INSTRUMENTS AND CONTROL SYSTEMS

MARCH 1960

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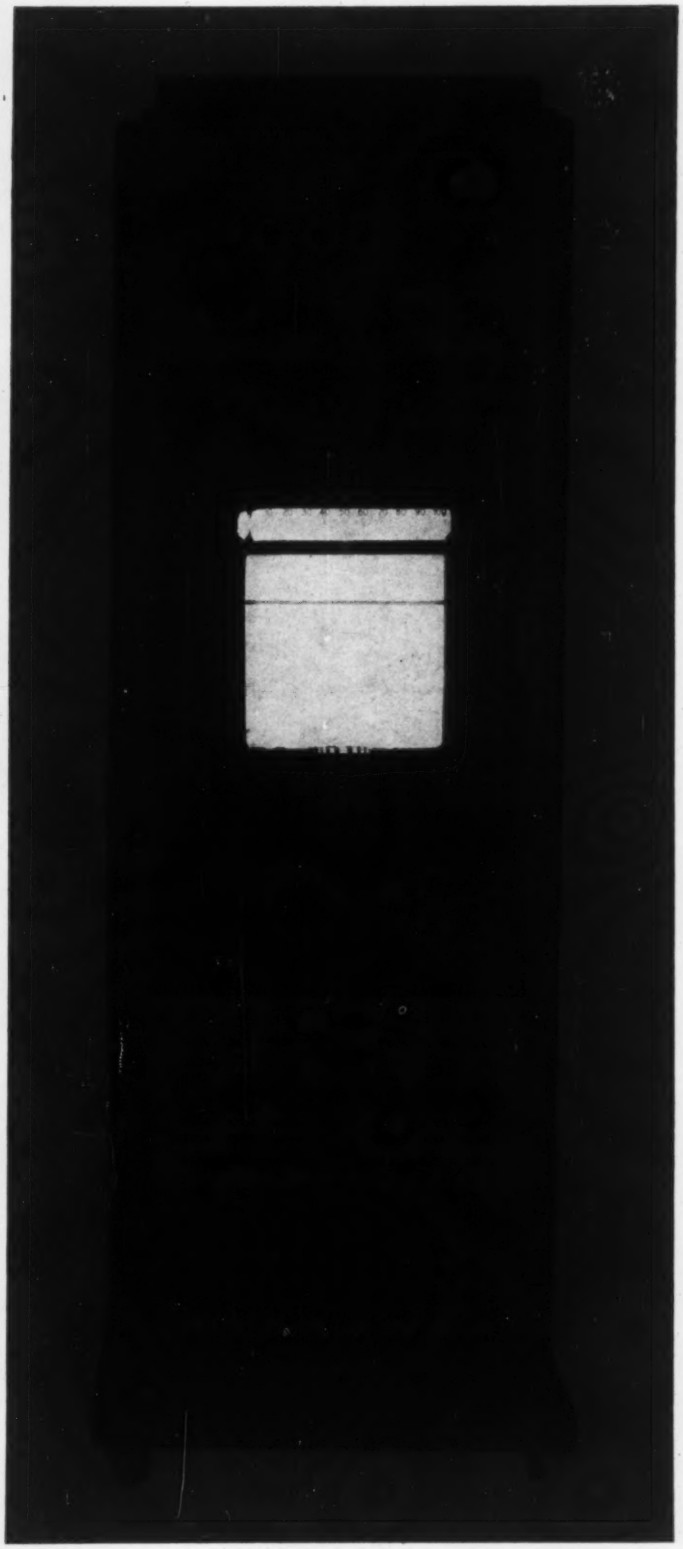
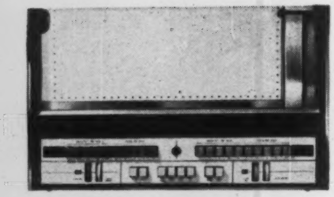


INCLUDING: INSTRUMENT MANUFACTURING • JOURNAL OF THE SCMA • SIMULATION COUNCIL NEWSLETTER



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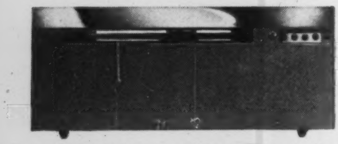

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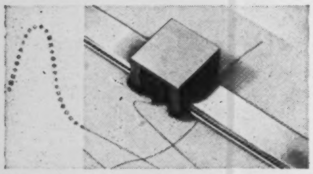

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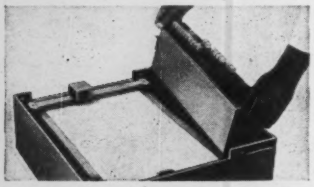

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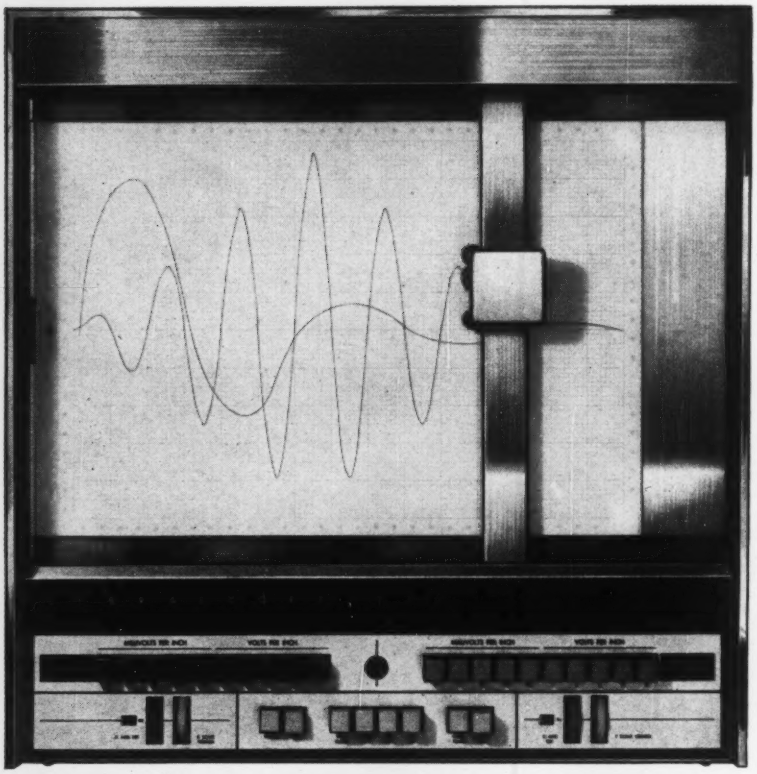

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point plotting or continuous trace

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PLOTTER CALIBRATION ACCURACY: .05% on all scales.

SLEWING SPEED: 20" per second.

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LI 9-20

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LEWIS

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MODEL 73PO

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FOR MEASURING TEMPERATURES
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Aluminum Case 5⅜" x 7¾" x 3¾"
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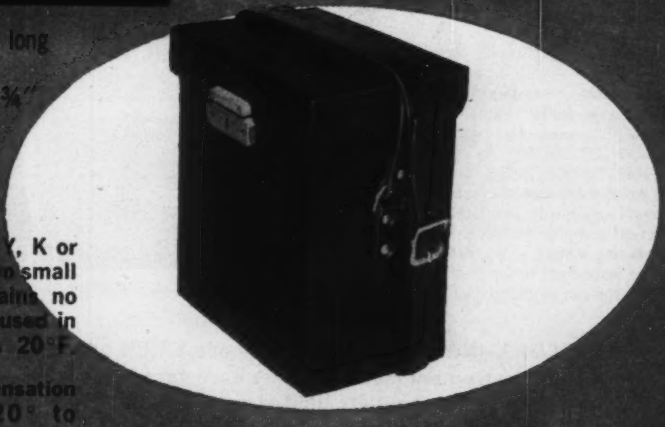

Calibrated for use with Type J, Y, K or T thermocouples. Operated by two small flashlight cells, the 73PO contains no standard cell to freeze, can be used in temperatures as low as minus 20°F.

Electrical cold junction compensation insures accuracy from —20° to +120°F. ambient temperatures.

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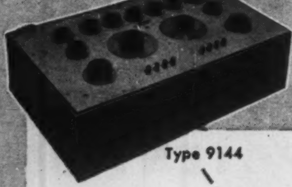
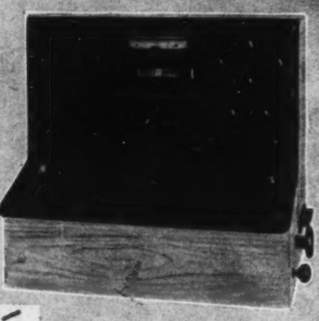


Type 9144

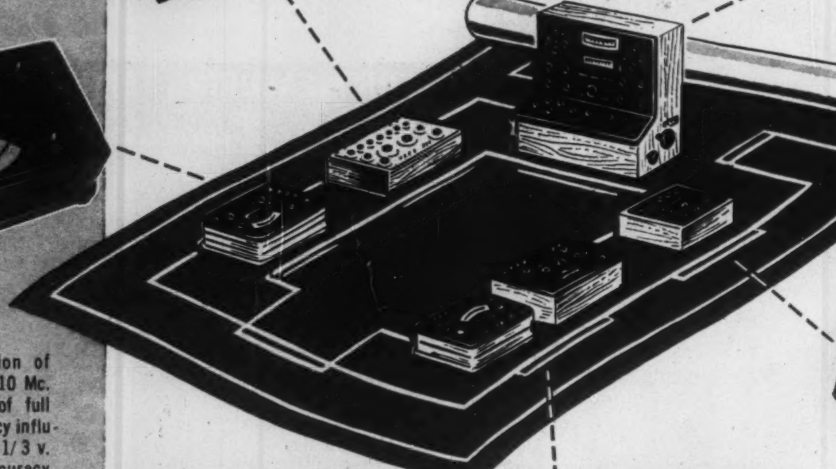
Calibration Console. Accuracy ± .05% of actual reading DC to 25kc. Ranges .5v. to 1111v. and 1 ma. (2 ma. on AC) to 11.11 amps in decades of .1v. and 1 ma. Resolution ± .01%. Direct readout in % error as well as in actual values. Console consists of a Hermach type AC-DC thermal transfer standard and a separate DC Calibrator. Complete with ± .005% stable reference source, high sensitivity galvanometer and self contained controls. Designed for one-man operation! Model LT-PS is a wide range, low distortion (.1%), highly stable AC power supply designed to operate within the full capabilities of the console.

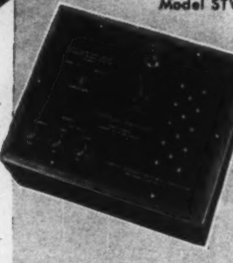


Model LTC

Model RFVC

Radio Frequency "Self Checking" RMS Voltmeter for the certification of VTVM's from DC to 10 Mc. Accuracy ± .3% of full scale, ± .2% frequency influence. Ranges .01/.1/1/3 v. Checks its own accuracy against a .05% stable internal standard source. Instrument reading with changes in frequency is stable and exactly reproducible. Diamond Pivoted of course!





Model STV

± .01% accurate, ± .005% stable DC reference source! Ranges 1.0000v. and 1.0185v. For use with "null balance" devices such as potentiometers and other infinite impedance comparators. Unaffected by vibration, extremes of temperature, or changes in operating position. Can be short circuited indefinitely without affecting accuracy or life expectancy. Input 90-140v. at 15°c-35°c.

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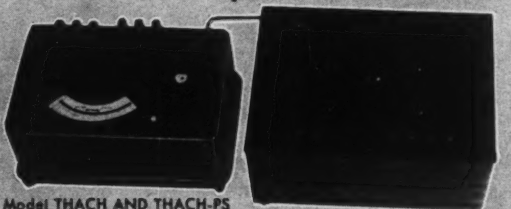

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MARCH
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T-2 **HIGH BRIGHTNESS and REGULAR TYPES**

DIALCO's Sub-Miniatures use tiny T-2 Neon Glow Lamps: *NE-2J (High Brightness)* at 105-125 V., A.C.; or *NE-2D* (regular) at 105-125 V., A.C. or D.C.

NEW Series mounts from *FRONT* of panel in 15/32" clearance hole (supplements 17/32" Series). Also—units for mounting from *BACK* of panel in 15/32" clearance hole. Unique lenses in 5 colors; give all-angle visibility. Units are fully insulated; meet applicable Mil. Specs.

Ask for Brochures L-159B and L-162.

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INSTRUMENTS
AND
CONTROL SYSTEMS

VOL. 33 NO. 2 MARCH, 1960
PRINT ORDER THIS MONTH: 35,650

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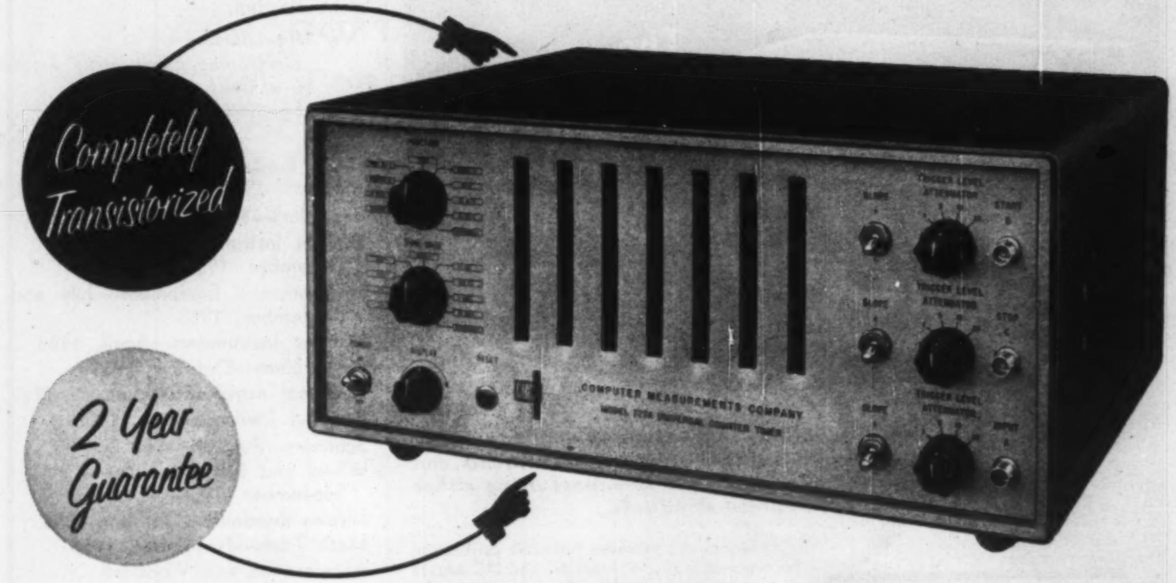
Solid State Reliability IN A 10 mc Counter



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DO ALL THESE JOBS

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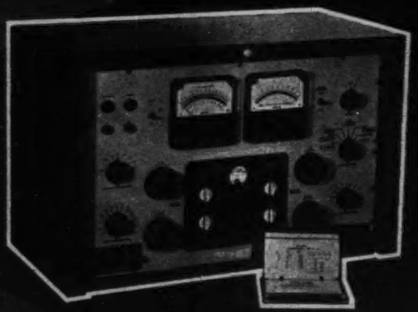
A Division of Pacific Industries
12970 Bradley Avenue, Sylmar, California
Phone: EMpire 7-2161

CIRCLE 5 ON READER-SERVICE CARD

Instrument Calibration

HEADQUARTERS



The proven method of maintaining Accuracy

Improved reliability and sustained quality control, through periodic calibration of test instruments, can be achieved by semi-skilled personnel using either of these self-contained standards.

Model 829 provides full-scale calibration accuracy of 0.5% for both AC and DC meters over ranges from 0.25 millivolt to 2000 volts and 2 microamperes to 20 amperes. AC calibrations can be performed from 50 to 400 cps., depending on line frequency used, or unit can be driven by optioned variable frequency power supply. Automatic protection for both operator and instrument under test is provided by interlocks and high voltage discharge circuits. Net price $2,650.

Model 829A provides full-scale calibration accuracy of 0.25% for AC and DC meters over same ranges as Model 829. Horizontally mounted standard meters are employed, and a fluorescent light is provided for proper illumination. The illustration shows the Model 829A mounted on the Model 10 Test Equipment Cart with the standard meters recessed into a drop-leaf work shelf. Mounted inside the Cart is the Model 500 Variable Frequency Power Supply which will supply any frequency for calibration from 50 to 400 cps., plus excellent line regulation. Net price of Model 829A with special Weston meters is $3,150.

Performance is rigidly guaranteed. Prices are f.o.b. Boonton, N.J. and subject to change without notice.

SEND FOR TECH. DATA

For additional information, including application data, write or phone DE 4-3100. Demonstrations available by local representatives.

RFL Radio Frequency LABORATORIES, INC.
Boonton, New Jersey, U.S.A.

CIRCLE 6 ON READER-SERVICE CARD

LETTERS TO THE EDITOR

Editor, I&CS:

Please send us a list of the survey articles, such as the one on Data Loggers in your December issue, which you have run in the last year or so. We find them helpful in equipment selection.

Hy. Olken
Electronics Engineering Dept.
U of Calif.
Livermore, Calif.

Strain Gage Equipment—March, 1958
Recorders—May, 1958
Weight Instruments—December, 1958
Environmental Equipment—July and September, 1958
Nuclear Instruments—April, 1958
Delay Lines—October, 1958
Electrical Instruments—January, 1959
Readout Devices—June, 1958
Scanners—August, 1958
Wheel and Belt Readouts—September, 1958
Display Readouts—October, 1958
Math Tools—November, 1958
Acceleration and Vibration Equipment—April, 1959
Printers—May, 1959
Viscosity—June, 1959
Compensation Devices—August, 1959
Potentiometers, Bridges—September, 1959
Pressure Recorders—October, 1959
Loggers—November and December, 1959
Control Computers—December 1959 and January, 1960
Temperature—January, 1960
Acceleration Generators—February, 1960
Vibration Testers—February, 1960

Editor, I&CS:

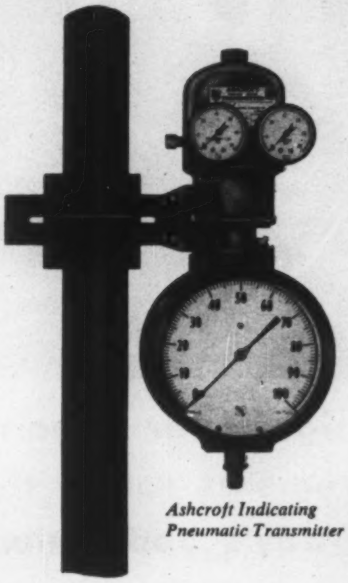
Referring to your proposed policy that any two articles published in your magazine should not appear on the same page or on the reverse side of the page, we say "fine".

We should like to go one step further, however, and suggest that if the size of the article warrants, that it not be broken up by making one column of article and one column of advertising.

Emil J. Marslek
Surface Finishes, Inc.
Addison, Ill.

signal

ASHCROFT PNEUMATIC TRANSMITTERS give you a true primary and transmitted signal for indication or control



Ashcroft Indicating Pneumatic Transmitter

action

Now—detect with precision accuracy the slightest change in primary pressure or temperature. Transmit this signal quickly to your indicators or controllers. Ashcroft Pneumatic Transmitters achieve these results for you at the lowest initial and operating costs.

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CIRCLE 8 ON READER-SERVICE CARD

LETTERS TO THE EDITOR

Editor I&CS:

Mr. Kaufman gives the wrong impression when he says that I "stated that the *words* 'probable error' should be standard deviation. . . ." I propose the use of the standard deviation or analog of it. One kind of standard deviation can be obtained by repeated comparison of two instruments with each other; another kind from comparison with a standard. It is agreed that this is a complex field. A discussion of the mathematics appears in *Tables on the Bivariate Normal Distribution Function and Related Functions,* NBS Applied Math Series 50, June 15, 1959.

E. Harvey Barnett
Statistics Group
Monsanto Chemical Co.
St. Louis, Mo.

Editor, I&CS:

In the July, 1959 issue of your magazine you indicate by an article of Mr. Roy Horton, page 1024, the existance of automation control valves of small sizes for low pressures. We would appreciate your furnishing us with the addresses of manufacturers of such valves.

Societe de Produits Chimiques
Courrieres-Kuhlmann
Harnes (Pas-de-Calais)
France
Plant Manager

Editor, I&CS:

I refer you to Reader Inquiry NR A-335, September 1958 issue of I&CS. I suggest that the Belgian development company seeking cartographic equipment investigate the feasibility of utilizing the M-1 Land Odograph developed by the Monroe Calculating Machine Company (Orange, N. J.) for use by the US Army.

The ODOGRAPH, land, Model M-1 was developed for use by the Army to do hasty mapping in theaters of operation—principally in areas where no mapping existed. Details of its operation and installation are covered in War Department Technical Manual (TM) 5-9401, dated 7 September 1943. Copies of this Technical Manual are unclassified and may be obtained from the US Government printing Office, Washington 25, D. C. A nominal charge is made to cover printing, of course.

In general the Land Odograph is a mobile cartographic drafting instrument, designed or mounting in a standard ¼ ton truck. It is driven from the transmission of the vehicle and actuated by a special compass. The plotting table is about 18″ by 12″ in size and the instrument will plot the course of the vehicle to most any desired scale. It either traces its own course or can be used to follow a predetermined course plotted on a map attached to the table. Accuracy is more than sufficient for normal military use. The magnetic compass is extremely sensitive and must be calibrated for a particular vehicle and driver. My father used 21 of these vehicular mounted odographs in survey work in the Aleutian Islands during World War II with excellent results. I have had limited experience with the Odograph in European operations and in Korea.

The Monroe Calculating Machine Company should be able to provide additional information. The usual approach through the American Military Mission in Belgium or through NATO should determine the availability.

Robert A. Atkins, Sr.
Major US Army
Ford Ord, Calif.

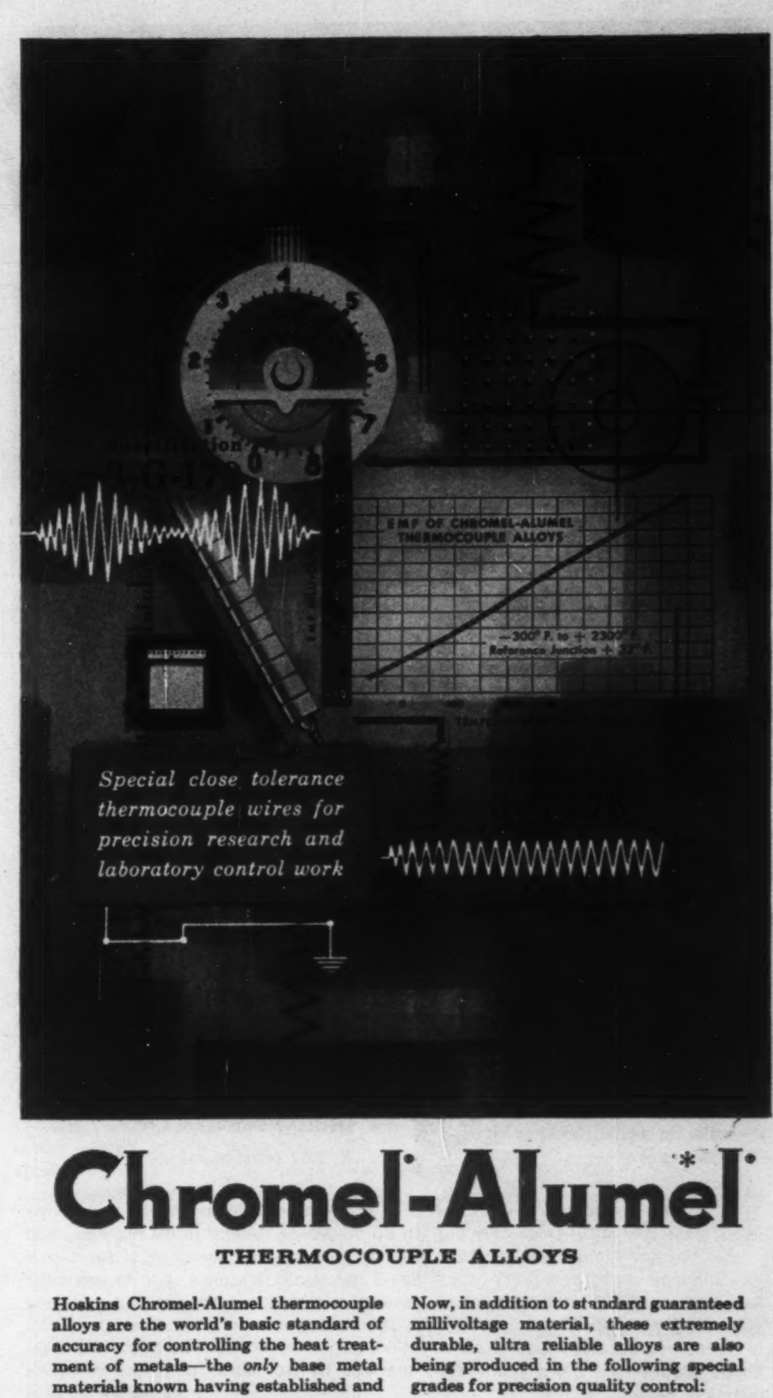
Editor, I&CS:

Referring to medical automation, should not the future first be preceded with a grouping of literature, which could well be done with IBM methods? Describe the patient, the symptoms and the treatment and finally, perhaps, the result. If a physician has a patient, he could send the data and symptoms to a central library, and with electromechanical means the literature pertaining to such cases is found, and an abstract is sent to the physician. Of course this would also require that all doctors send short reports to the information center.

Now, physicians generally have no time to read literature. They throw out all incoming literature (automatically by secretary). They read only the *Medical Digest* (something like *Readers Digest*) to pick out a few new drugs. They sell their time at the rate of $1 per minute, and "si la va, la va" as the Italians say.

Dr. George Keinath
Consulting Engineer
Larchmont, N. Y.

Here indeed is a most exciting and literally "vital" concept—EDPMs (electronic data processing machines) applied to diagnostic technique. This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LETTERS TO THE EDITOR

is but one of the possibilities that will be explored in the new forthcoming publication Medical Electronic News, which will be a sister publication of Instruments & Control Systems.

Editor, I&CS:

On behalf of the officers and members of the American Society of Tool Engineers, I would like to take this opportunity to congratulate you on your experiment in education at the highschool level.

We are all aware that most students entering colleges and universities have no idea what they plan to major in. This experiment may not only help students to make up their minds as to what fields they will enter, but will also give them a better knowledge of science.

This is a very worthwhile project.

J. A. Bircher, Chairman
Pittsburgh Chapter—A.S.T.E.
Pittsburgh, Pa.

Editor, I&CS:

With regard to your report on the Pittsburgh school program of Technicians, I think your group is making a fine contribution to the national educational program, which is worthy of copying elsewhere.

N. W. Hartz
Technical Products Division
Mine Safety Appliances Co.
Pittsburgh, Pa.

Most of the students went to college.

Editor, I&CS:

We hear and read so much about the status of Science education. Your editorials on Pittsburgh's high-school program are interesting. I hope that there is not too great a commercial aspect in the education experiment.

Equipment does not necessarily make a good educational program. The teacher is the key to the whole matter with, of course, adequate physical facilities and a respectable salary. You, of course, are aware that doubling the salaries of some teachers would not make them better teachers, but better salaries should attract better teachers.

I am sure you agree that we can also have good educational programs including science courses without

Can A Ball Valve Operate, Cycle After Cycle, With No Maintenance At All?

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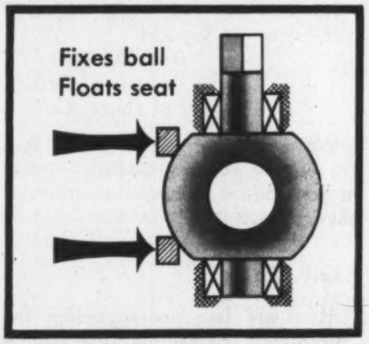
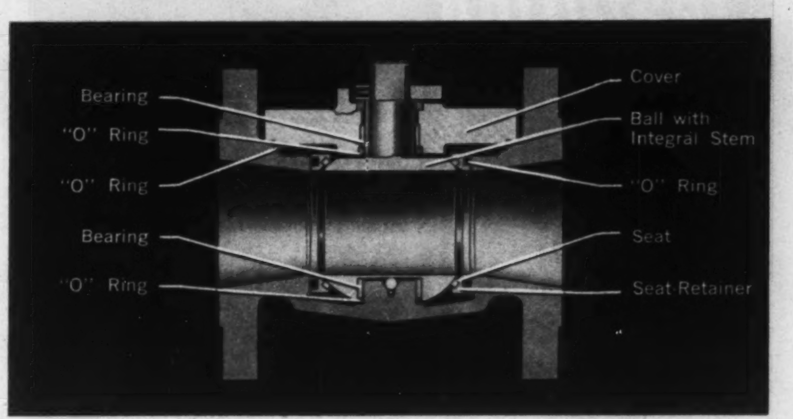
As most engineers know, ball valves offer a number of distinct advantages over all other types of valves . . . 90° on-off, minimum pressure drop, positive on-off indication, no lubrication, and compactness. In common with other valves, however, the design was insufficient to overcome the problem of continual maintenance.

Four years ago, this problem was faced by Hydromatics, Inc. in the valves that they produced for use in missiles, aircraft and ground support systems. Then, as today, all other ball valves were built with a ball that floated in its socket, and sealed by being forced against its seat by the pressure in the line. This caused seat distortion which made early replacement necessary.

Hydromatics tried a different approach. Rather than use the traditional floating ball, their engineers fixed the ball in bearings.



In the bearing-fixed **FLO•BALL** valve all pressure forces exerted on the ball are transmitted to low-friction bearings, thus eliminating down-stream seat distortion due to ball load. The pressure balanced seat, with its teflon sealing surface, is continually self-adjusted by the O-ring in the seat retainer.

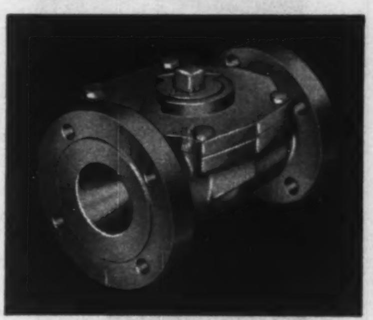


This O-ring acts as a self-energizing force that keeps the teflon seat always in contact with the ball. This insures positive sealing without seat distortion, and minimizes seat-resisting frictional forces. The combination of these low frictional forces results in low operating torque and extremely long seat life.

The bearing-fixed **FLO•BALL** valve proved itself immediately. Hundreds of missile and spacecraft systems, previously impossible, were made possible with these valves. The X-15, America's first manned space vehicle, for instance, has a Hydromatics **FLO•BALL** valve at its heart. Since its inception, the **FLO•BALL** has been used in more varied applications than all other ball valves combined.

Now, after the toughest application testing in history, bearing-fixed **FLO•BALL** valves are being mass produced for industry. They are available for off-the-shelf delivery to standard ASA dimensions in semi-steel, carbon steel, stainless steel, and aluminum. They operate at pressures to 600 psi, temperatures to 400°F and hold vacuum to 10^{-6} mm. of Hg!

The bearing-fixed **FLO•BALL** offers extra ball valve advantages. Top loading for easy access without removing the valve from the line, plus three features that are absolutely unique! Self-adjusting seats which automatically compensate for wear, proportional sealing force which automatically increases with line pressure, and the lowest torque, by far, of any valve. These combine to make the **FLO•BALL** valve virtually maintenance-free!



How long does it last without maintenance? Frankly, we don't know, since the first valves we ever built are still going strong and outlasting other valve types by more than 10-to-1. But don't take our word for it. See for yourself. Call, write or TWX for further information.

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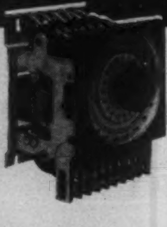

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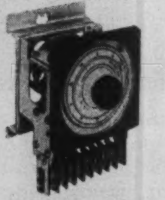

model HZ200
ADD-SUBTRACT COUNTER

Add-Subtract counter — operates from ADD pulses which trip switch at maximum limit — and SUBTRACT pulses which trip switch at "0" limit.

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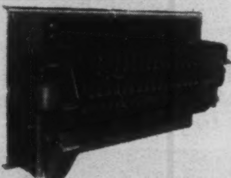

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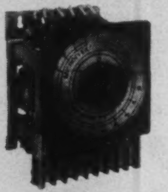

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LETTERS TO THE EDITOR

Federal aid. It is not absolutely necessary.

Regarding the objectives of your experimental program in Pittsburgh, I feel they could be improved upon. Brief demonstrations with technical equipment may not create a learning situation if students are not well qualified in the fundamentals.

I look forward to hearing more about your experiments. Progress will only be made through such endeavors.

E. W. Tischendorf, Professor
and Head, Industrial Arts Dept.
Kent State University
Kent, Ohio

The demonstrations are used primarily to teach fundamentals—and the students are soaking up the fundamentals at a rate far in excess of normal. The teacher has been carefully selected and specially indoctrinated. In the absence of Federal aid, this experiment becomes significant; with Federal aid much more could be done.

Editor, I&CS:

May I congratulate you on your excellent editorial in the March issue, and also for the fine article in February on the Pittsburgh High School Physics Program.

As chairman of the education committee for West Coast Electronic Manufacturers Association (San Diego Chapter), I could make good use of some reprints of these two editorials. If convenient, I would like to have about 10 copies of each.

Keep up the good work. You will find plenty of support.

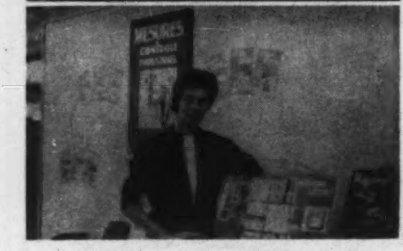
D. C. Kalbfell
Kalbfell Electronix
San Diego, Calif.

We need that support. We feel like David fighting a Goliath—trying to get modern instrumentation into a physics class!

Editor, I&CS:

Here are two pix regarding the "Mecalanec" Exposition, that inaugurated the new Exposition Palace which Paris now owns at the "Defense Circle."

One gives the general view of the first floor of the hall with the central platform of the National Center of Automation; the other gives a view of our booth, on the left of which several issues of I&CS were displayed



which frequently were inspected by visitors; our booth was located in the center of the "Measuring, Control and Regulation" section, of which our September issue reported in detail.

J. Vivie
Mesures & Controle Industriel
Paris

Editor, I&CS:

I've written over 500 letters, surveying industry to determine views on technician training.

The interesting thing about this survey is the amount of enthusiasm for it that is displayed at all levels. Some of my longest letters come from company executives. And opinions are not merely varied. Some are in rather violent opposition, indicating that, unless someone is pursuasive enough to get these people together, supporting one common solution to our educational problem, no solution at all will ever be effectuated.

This situation exists at a time when a group of educators have just reported on a trip to the Soviet Union in which they became convinced that the Soviet has a more effective and productive educational facility than we.

Maybe if some of the effects of sophistry can be overcome in the realm of technician training, it will encourage the same thing in regard to problems in education at all other levels. Maybe our Educator's Workshop can evolve some pattern.

A. G. Hathaway
United Electronics Laboratories
Louisville, Ky.

Our country has no firm leadership on many problems, only one of which is education. In the absence of such leadership we can expect just this—many plans by individual groups, all opposed violently by many other small groups. This is Democracy—without leadership.

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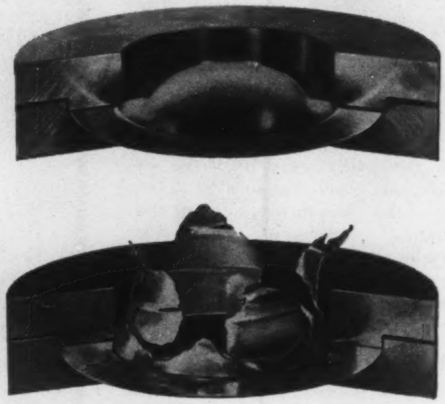

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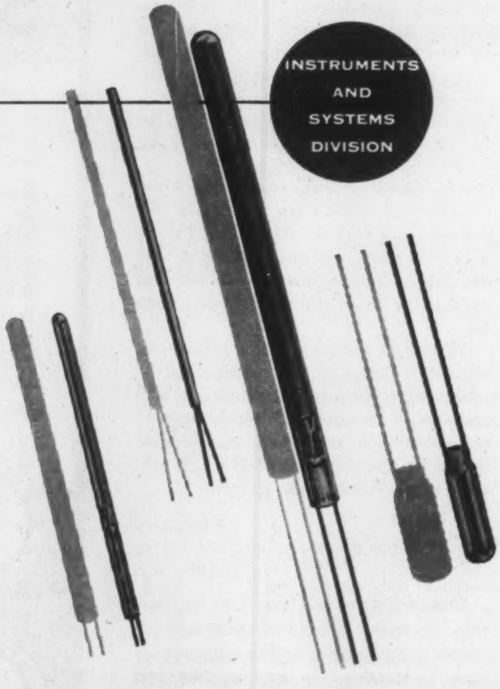

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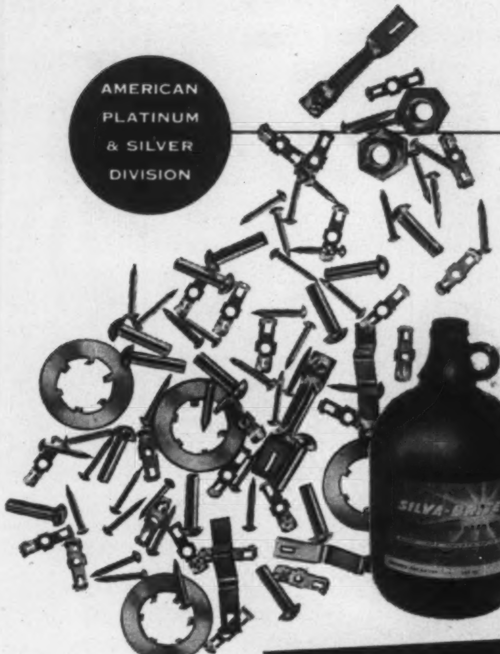

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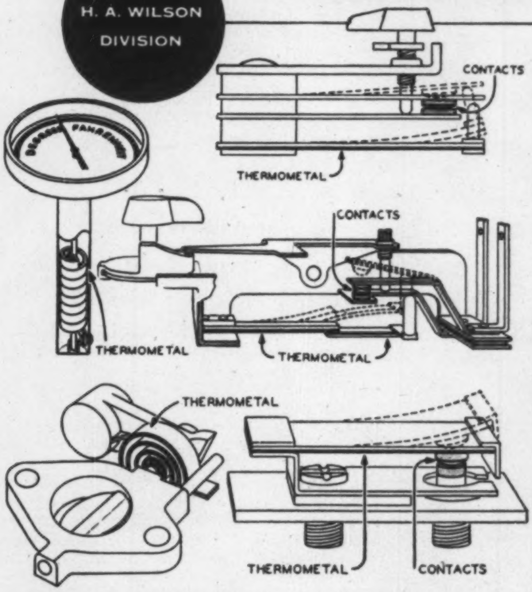

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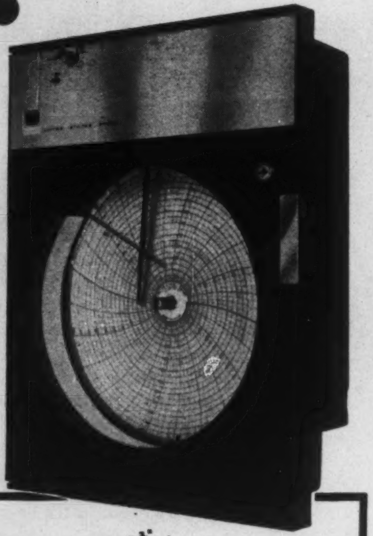

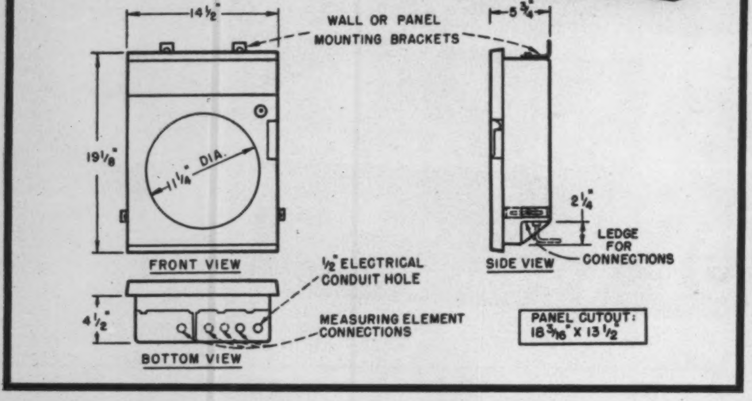
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LETTERS TO THE EDITOR

Editor, I&CS:

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The inquiries which we receive are of great value to us in letting potential customers know about our products. They also serve as stimuli to our sales force.

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Librarian of industrial concern is trying to identify a Tapley meter (presumably an accelerometer). A-612

Gold Assay Recorder

Manager of Instrument Sales company in Australia seeks manufacturer of an "instrument for the continuous or batch recording of tailings of gold assay to the degree of one penneyweight to the ton=0.00016%, suggesting a range from 0.0005% to 0.002%. This appears to be an arc photometer." A-611

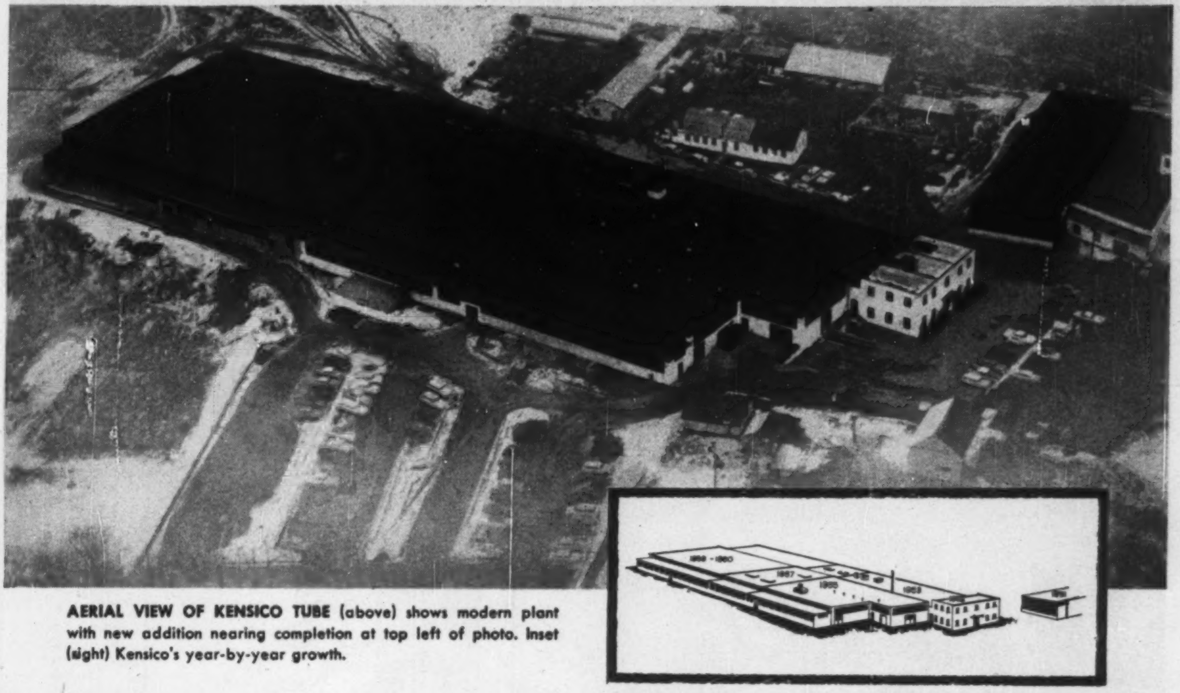
Card Punching Device

Engineer seeks name and address of company (presumably located in N. H. or Vt.) manufacturing card punching device known as "V.I.P." A-610

Oil Well Instrumentation

Exporter seeks supplier of (1) instruments for the determination of space forms and volumes of underground vehicles for natural gas, oil, air, etc. through drilling wells of small diameter, consisting of transmitters and recorders; (2) automatic densimeters for condensed gases and oil mounted on the equipment of the well mouth; (3) distance densitometers which are lowered into oil and condensed-gas wells; (4) positive-displacement meters for water, oil products, and condensed gases; and (5) interface meters for oil, oil products, and condensed gases in the underground reservoirs at a depth of 1000 to 1200 meters. A-609

SET FOR THE SOARING SIXTIES



AERIAL VIEW OF KENSICO TUBE (above) shows modern plant with new addition nearing completion at top left of photo. Inset (sight) Kensico's year-by-year growth.

PACE-SETTER during a period of phenomenal growth in northern Westchester County, N. Y. Kensico Tube is Mt. Kisco's largest manufacturing business. Products include: hard and soft copper water tube; copper air conditioning, refrigeration and instrumentation tube; and copper tubing for propane gas lines, heat exchangers, automotive and industrial applications. Now, after more than a decade of corporate growth and expansion of production and marketing facilities, Kensico is set to meet the challenge of the SOARING SIXTIES.

IN 1950, CONSTRUCTION of first new building was started. Kensico had been chartered under N. Y. State Law in 1945. Under present management since 1948. Until 1951, company was located in an old cider mill which it leased (floor space 8500 sq. ft.).

TODAY, AFTER PUTTING UP 4 MORE ADDITIONS, Kensico has more than 60,000 square feet of modern fireproof plant and office space.

BY SPRING, 1960, Kensico expects to complete a new 40,000 square foot addition to the plant. Total plant and office space will then exceed 100,000 square feet.

PRODUCTION HAS INCREASED with each addition since 1950. It will be still further increased in both capacity and range of sizes by the new 1960 addition.

IN THE TEN YEAR PERIOD, 1950-1960, Kensico has had a 7-fold growth in gross sales.

EFFECTIVE FEBRUARY 1st 1960, Kensico Tube Company Incorporated, Mt. Kisco, N. Y., merged with Robinson Technical Products, Inc., Teterboro, N. J. Robinson also has other corporate facilities at Hingham, Mass., and Santa Monica, California. The merger strengthens Kensico's position in engineering and metallurgy and places new technological know-how and experience at the disposal of Kensico's customers. Kensico's new name is KENSICO TUBE COMPANY DIVISION — ROBINSON TECHNICAL PRODUCTS, INC.

Kensico Tube
COMPANY DIVISION
Robinson Technical Products, Inc.

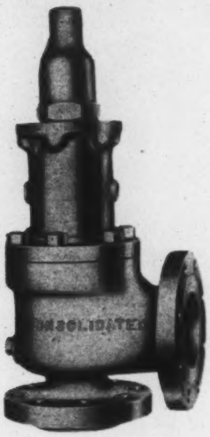
MOUNT KISCO, NEW YORK

Kensico Products are also Available Through Warehouse Distributors and Sales Representatives in Cambridge, Mass.; Middlebury, Conn.; Buffalo, N. Y.; Lindenhurst, N. Y.; Goshen, N. Y.; Roselle, N. J.; Philadelphia, Pa.; Flourtown, Pa.; Pittsburgh, Pa.; Cleveland, Ohio; Detroit, Mich.; Evanston, Ill.; St. Louis, Mo.; Milwaukee, Wisc.; Durham, N. C.; Berwyn, Ill.; Ft. Lauderdale, Fla.; St. Petersburg, Fla.

CIRCLE 19 ON READER-SERVICE CARD

top

CONSOLIDATED SAFETY RELIEF VALVES have a special "O" Ring Seat Seal that stops leakage completely



Consolidated Safety Relief Valves are available in both Standard and Balanced Bellows design for extreme corrosive applications.

tightness

The Seal is a resilient ring set in the valve disc. It maintains no-leak tightness by contact with a specially curved seating surface on the valve nozzle, yet does not carry the seat load imposed by the valve spring.

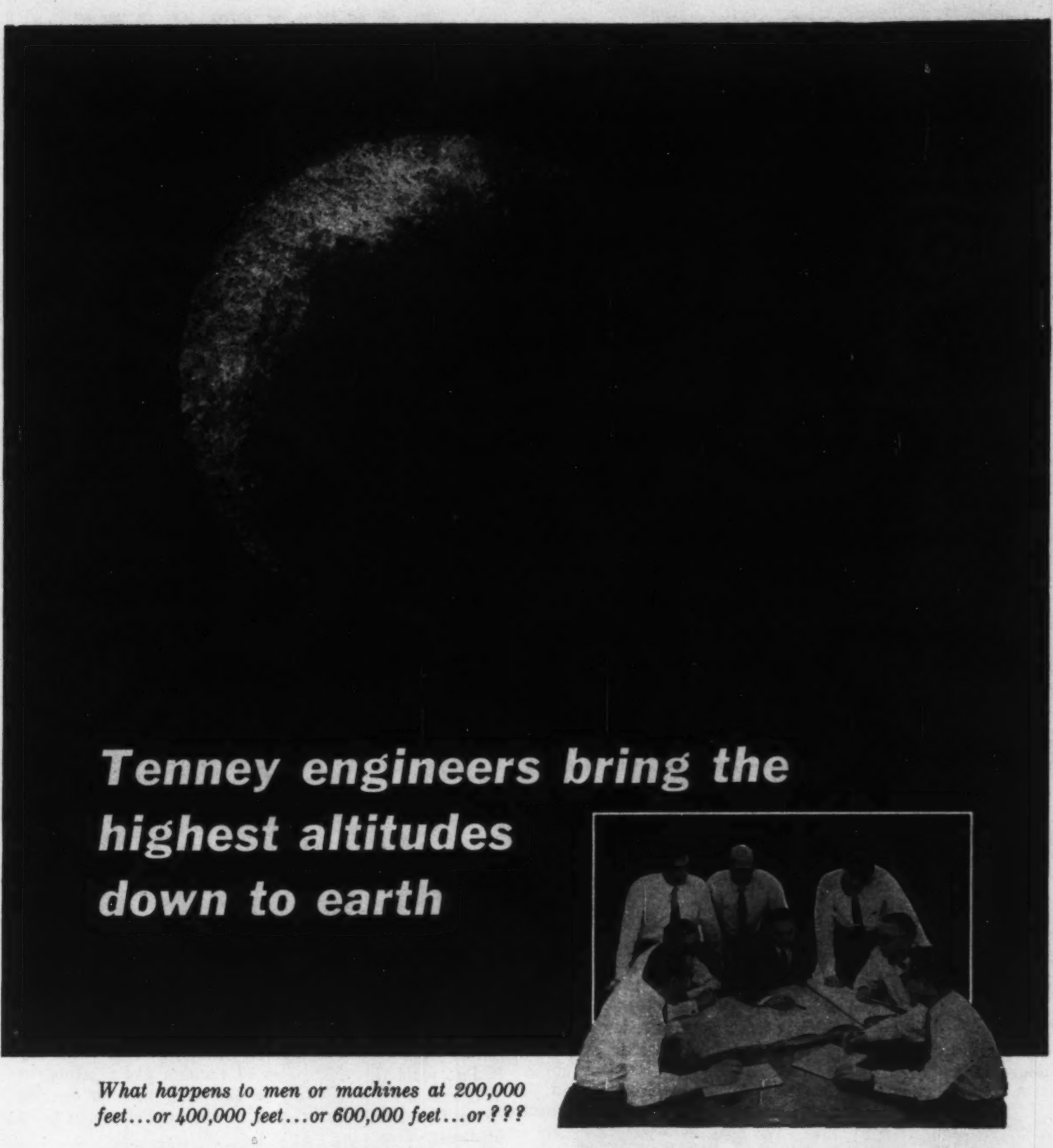
Tightness is maintained at operating pressures far closer to set pressure than with metal-to-metal seats alone. Tight closure is as efficient after "simmer" as on normal blowdown. Piping strains are absorbed far better by the resilient seal than all-metal seating. If the tough seal is ruined by entrained abrasives, replacement is easy. Seals are available in materials that resist corrosive fluids. Maintenance costs are greatly reduced.

Standard Consolidated Safety Relief Valves have an eductor tube that removes pressure from the closed bonnet. Only the spring controls valve action. You get guaranteed capacity ratings and highest dependability—absolute protection for personnel and equipment. Additionally, there is the economy of converting the Standard valve to the Balanced Bellows type in your own shop. Get complete details. Write for Bulletin 1940.

MAXWELL
MANNING
M & M
& MOORE INC
TRADE MARK

CONSOLIDATED SAFETY RELIEF VALVES
A product of
MANNING, MAXWELL & MOORE, INC.
Consolidated Ashcroft Hancock Division • Tulsa, Oklahoma
In Canada: Manning, Maxwell & Moore of Canada, Ltd., Galt, Ontario

CIRCLE 20 ON READER-SERVICE CARD

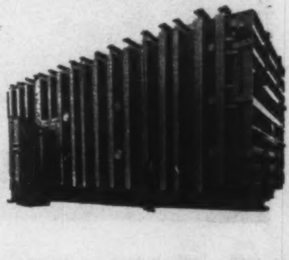

Tenney engineers bring the highest altitudes down to earth

What happens to men or machines at 200,000 feet...or 400,000 feet...or 600,000 feet...or ???

Tenney Engineering has pioneered in the development and manufacture of environmental chambers that simulate the extreme conditions encountered at exceptionally high altitudes. No other engineering group has as much combined experience in this particular activity.

If the rigors of high altitude must be met by your products, investigate the environmental chambers, standard or custom-designed, manufactured by Tenney, world leader in environmental equipment. Write for complete information.

Tenney
ENGINEERING, INC.



1090 SPRINGFIELD ROAD, UNION, N. J. PLANTS: UNION, N. J. AND BALTIMORE, MD.

OLDEST AND LARGEST MANUFACTURER OF ENVIRONMENTAL EQUIPMENT

CIRCLE 21 ON READER-SERVICE CARD

Glass Temperature Controlled to ¼°F

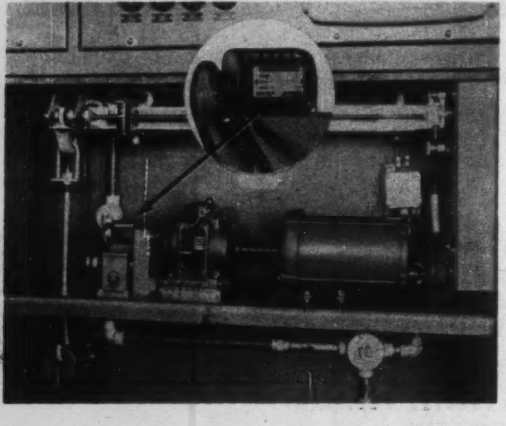
PITTSBURGH, PA.—Four giant batteries of electronic temperature controllers help spin the glass fiber yarn produced at the Shelby, N. C. plant of Pittsburgh Plate Glass by maintaining temperatures at the platinum bushings to within ±¼°F at 2200°F. The 240 CPM-1 controllers (three to a vertical bank) made by Hagan Chemicals & Controls, Inc., P. O. Box 1346, Pittsburgh 30, Pa. are responsive to thermocouple fluctuations of one-millionth of a volt.

CIRCLE 165 ON READER-SERVICE CARD

Gravimetric Feeder System Uses Precision Counters

MILWAUKEE, WIS.—The flow of materials is automatically totalized and over- and underfeed is corrected in a Continuous Loss-in-Weight Gravimetric Feeder, manufactured by B-I-F Industries, Omega Division, Providence, R. I.

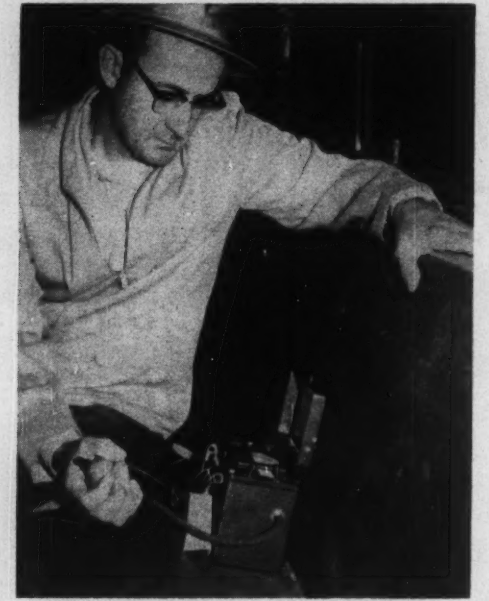
A non-reset counter (Model D-6) driven from a lead screw which has a known weight per revolution, and by chain and sprocket of correct ratio to the lead screw is used in conjunction with the automatic flow control, to make a record of the number of turns the lead screw has made, so that the exact amount of material that has been fed can be accurately measured to correct any degree of over- or underfeed. The counter is made by Durant Mfg. Co., 1981 North Buffum St., Milwaukee 1, Wis.



CIRCLE 166 ON READER-SERVICE CARD

Ferreting-out Air Leak into Gas Line

PITTSBURGH, PA.—A roving detection system consisting of a small air compressor, mounted on the motor of a half-ton pickup truck and a portable oxygen indicator is being used to locate air leaks. The compressor which is driven by the engine pulls the sample of gas from the vacuum line and discharges it through the portable oxygen analyzer which indicates the amount of oxygen in the sample.



The Portable Oxygen Indicator, designed by Mine Safety Appliances Co., 201 N. Braddock Ave., Pittsburgh 8, Pa., patrolling 250 miles of vacuum gas pipeline, has achieved a 50% savings in sampling time at the Salt Creek Gasoline Plant of Pan American Petroleum Corp., Midwest, Wyo.

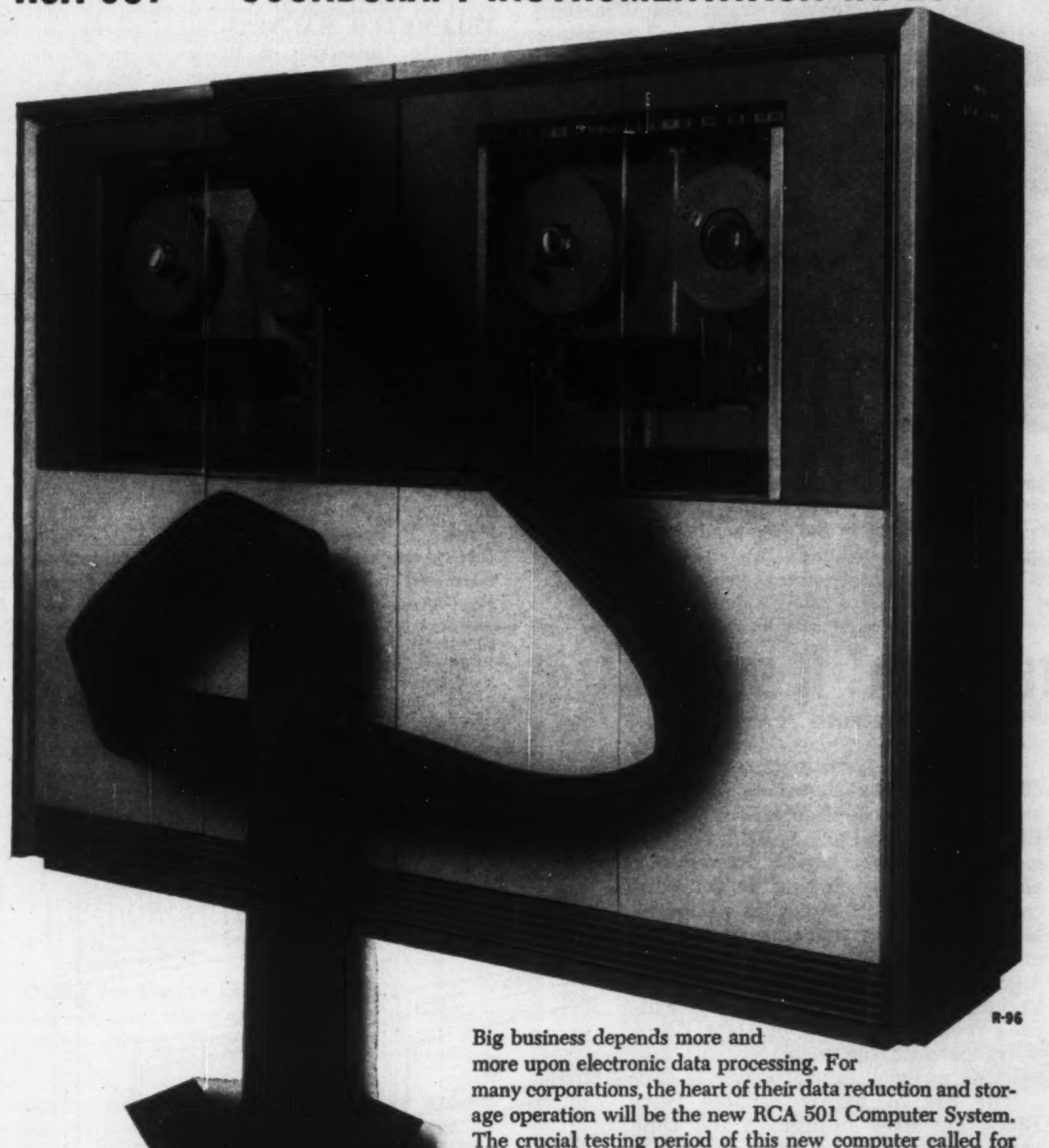
CIRCLE 167 ON READER-SERVICE CARD

EASTERN REGIONAL SIMULATION COUNCIL held its bi-monthly meeting December 14, 1959 at Leeds & Northrup's new R&D Center. 95 members heard 6 technical papers on the theme of "Automatic Control in the Process Industries," and elected Sydney Korn of Sylvania Electronic Systems 1960 chairman.

DIGITRONICS CORP. has installed a custom-designed bi-directional converter (Model D104) in the brokerage house of Bache & Co. It converts data from magnetic tape to teletype tape at a rate of 2400 words/min and vice versa 3000 words/min.

WORKING PARTNERS

RCA 501 — SOUNDCRAFT INSTRUMENTATION TAPES



Big business depends more and more upon electronic data processing. For many corporations, the heart of their data reduction and storage operation will be the new RCA 501 Computer System. The crucial testing period of this new computer called for the most reliable of instrumentation tapes . . . Soundcraft. And, Soundcraft Tape proved to be the perfect working partner—not only in the testing, but afterward, in continuous working use.

In short, experience has proven that Soundcraft works best on leading computer systems, like the RCA 501. Let precision-made, trouble-free, error-free Soundcraft Instrumentation Tapes go to work for you. *Complete literature on request.*

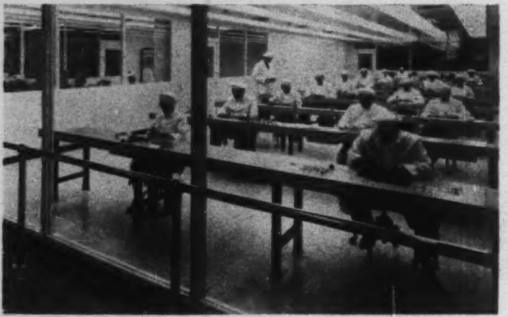
REEVES SOUNDCRAFT CORP. Great Pasture Rd., Danbury, Conn. • Chicago: 28 E. Jackson Blvd.
Los Angeles: 342 N. LaBrea • Toronto: 700 Weston Rd.

CIRCLE 22 ON READER-SERVICE CARD

ICS **NEWS**

Counter Manufacturer Uses White Room

HARTFORD, CONN.—Environmental control in the assembly room of small counters has enhanced considerably the quality of these devices which perform vital functions in missiles and in industry.



In a glass-walled area in the main Veeder-Root plant there are streamlined benches of molded plastic, and workers (wearing white nylon smocks to reduce the incidence of dust and lint in the air) handle stainless-steel or brightly chrome plated tools. An efficient air-conditioning system maintains a constant temperature of 72°F in the "white room," at a relative humidity of 50%.

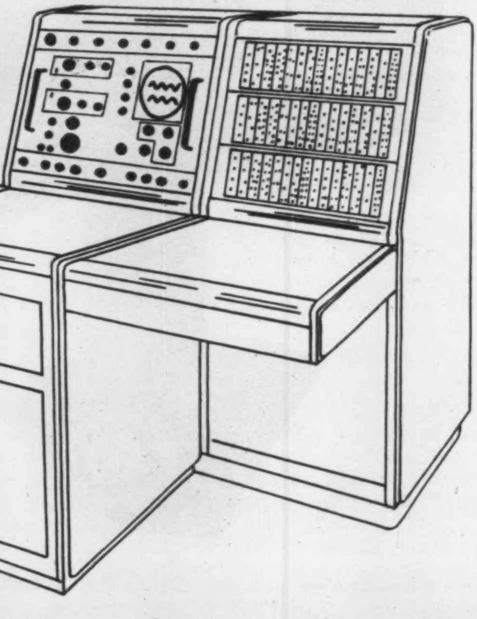
When parts enter the "white room," they are washed in an ultrasonic washing device, and then placed in covered plastic trays from which the women, working mostly with tweezers and other small tools, lift the parts from the compartmented trays and assemble them in special jigs and holders. This special facility was designed and built by Veeder-Root Inc., Hartford, Conn.

CIRCLE 168 ON READER-SERVICE CARD

TELEMETER MAGNETICS has received a contract from the University of Illinois to manufacture core planes for a magnetic-core memory unit to be included in a computer under development in the University's Digital Computer Lab. The computer will use linear select techniques rather than the coincident current approach in general use today, with operating speeds approaching a rate of 500,000 operations per second. The project is being supported by the AEC and the Office of Naval Research.

BELL AIRCRAFT is developing a plasma-jet generator utilizing the extreme heat released by plasma, the fourth state of matter, to produce temperatures up to 18,000°F. It separates the molecules in nitrogen or argon, then expels the charged particles through a small nozzle. The gas particles re-combine and this energy of re-association produces extremely high temperatures.

CASE INSTITUTE is offering a summer study course in Process Control Theory under the direction of Dr. Donald P. Eckman. Tuition fee is $400; the dates are July 11 through 29. Requests for applications may be addressed to Dr. James Hooper, Jr., CIT, University Circle, Cleveland 6, Ohio.



THE BETA* II SYSTEM
*BASIC ENGINEERING TRAINING AID

The versatility, economy and speed of operation that has been winning widespread acceptance for Data Bloc® and Data-Pac® units as modular components in digital activities is also particularly applicable for educational training purposes. Laboratory time is at a premium in today's educational training programs where much energy is consumed by the breadboarding of basic circuits. Pin-jack front panel logic of Data Bloc® units permits the most efficient and reliable programming today.

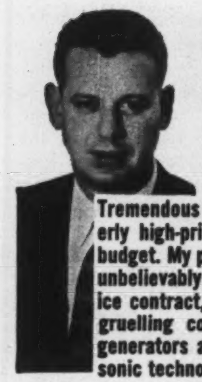
The use of highly reliable Data Bloc® circuitry minimizes the time required to derive a solution to any given problem and, therefore, permits accelerated logic development programs.

Upon completion of one problem, front panel pin-jack logic allows rapid preparation for the following problem.

HWW

HARVEY-WELLS ELECTRONICS, INC.
14 HURON DRIVE • EAST NATICK INDUSTRIAL PARK
NATICK, MASSACHUSETTS

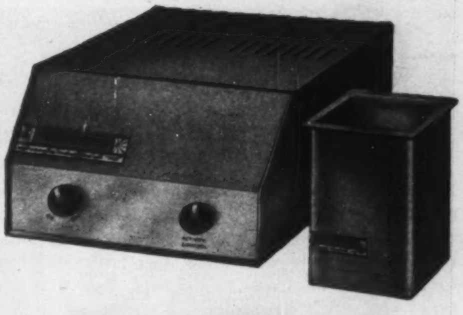
CIRCLE 23 ON READER-SERVICE CARD



My name is Paul M. Platzman,

I pioneered the ultrasonic industry. Two well known ultrasonic companies were founded by me. Now, I have created a new organization, Ultrasonic Industries, Inc., based on a revolutionary approach to mass producing and selling ultrasonic equipment. No middleman's profit in this factory — direct-to-you deal.

Tremendous savings are passed on to you the customer bringing formerly high-priced ultrasonic cleaners within the range of everybody's budget. My products stand out because of their distinctive appearance, unbelievably low money-back-guaranteed prices—free five year service contract, and consistent trouble free performance under the most gruelling conditions. This is possible because my DISONtegrator generators and transducers incorporate the latest advances in ultrasonic technology.



$99.95

Including tank, connecting cable and instruction manual (export model: 220V — 50 cycles $7.50 extra)

DISONTEGRATOR®
SYSTEM FORTY
ULTRASONIC CLEANER

The lowest priced ultrasonic cleaner ever sold! **Buy ONE or 100 and Save!**

The DiSONtegrator System Forty ULTRASONIC CLEANER is attractively styled, ruggedly-built, and work-tested to give a lifetime of trouble-free service.

The DISONtegrator Features:

Simplified one knob control for easy operation. High Frequency sound waves disintegrate harmful soils and contaminants in seconds.
Saves time and labor, boosts production rate, improves product. You can replace hazardous chemicals with safe solvents and even water.

The DiSONtegrator works FAST

In SECONDS you can disintegrate soils on: radioactive lab apparatus; glassware; medical instruments; test tubes, syringes, hypodermic needles; dental instruments, drills, burrs, false teeth, bridges; fossils and fossil foraminifera; electronic components, semi-conductors, crystals, switches, precision potentiometers; optical parts, lenses, plastic contact lenses, eyeglasses; timing mechanisms; small gear trains; miniature printed circuit boards; and hundreds of other items.

In seconds you can remove:

rust, oxides, shop dirt, dust, lint, preservatives, finger prints, machining chips, extrusion lubricants, paraffin, wax, paint, varnish, lacquer, plastic residue, resists, silicones, greases cooked food residue, blood, plaster of paris, lapping compounds, carbon, radioactive particles, polishing compounds, shale, diatomite, volcanic tuffs, clay and sand, graphite, starches, cutting oils, heat treat scale, color stains, foundry sand, abrasives, quenching oil, salts, pitch, asphalt, tar, inks, adhesives, jewelers rouge, tripoli, resin flux, acid flux, many others.

The DiSONtegrator is VERSATILE

In addition to super speed, surgical precision cleaning it can be used to: brighten, quench, degrease, impregnate, decontaminate, pickle, etch, dip coat, emulsify, degas liquids, anodize, dye, mix, accelerate reactions.

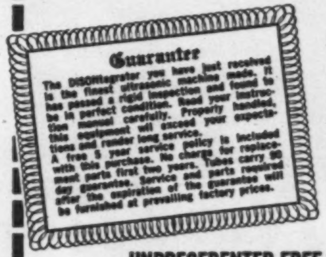
Ultrasonic cleaners are widely used

in production lines, maintenance departments and laboratories. You should have at least one DiSONtegrator if your field is Electronic, Optical, Glass, Clinical, Biological, Textile, Oil, Food, Paper, Dental, Plastic, Drug, Rubber, Wood, Chemical, Isotope, Geological, Agronomical, Metallurgical, Anthropological, Paleontological, Petrochemical, Ceramics, Dairy, Brewery, Beverage, Confectionery, Laboratories, Photographic, Paint, Bottling, Cosmetic, Pharmaceutical, Metal Working, Metal Finishing, Die-Casting, Foundry, Plating, Metal Treating, Automotive, Aircraft, Horological, Jewelry, Medical, Marine, Mining, Utilities, Power Plants, Instrumentation.

ultrasonic industries INC.
141 ALBERTSON AVENUE · ALBERTSON, L. I., N. Y.
Pioneer 1-4333

INTRODUCTORY OFFER

Money Refunded (less shipping charges) if not completely satisfied.



Guarantee

The DiSONtegrator you have just received is the finest ultrasonic machine made. It has passed a rigid inspection and found to be in perfect condition. Read your instruction manual carefully. Properly handled, this equipment will exceed your expectations and render long service. A free 5 year service policy is included with this purchase. No charge for replacement parts first two years. Tubes carry 90 day guarantee. Service and parts required after the expiration of the guarantee will be furnished at prevailing factory prices.

5-DAY TRIAL

We will pay all shipping charges to any point within the continental limits of the United States (not including Alaska and Hawaii), if you enclose check with order.

UNPRECEDENTED FREE 5 YEAR SERVICE CONTRACT

The DiSONtegrator — System Forty is available from stock for immediate delivery in unlimited quantities.

SPECIFICATIONS

GENERATOR INPUT: 117 V, 60 cycle — **GENERATOR OUTPUT:** 40 W, 90 KC
DIMENSIONS: GENERATOR: 10" L x 7" W x 5¾" H
Tank (overall): 6¼" L x 7" W x 6½" H
Tank (inside): 5¼" x 5¾" x 4" D
Tank (capacity): 0.5 gal.

FOR THE FIRST TIME — you have a choice of 6 beautiful decorator colors to harmonize with your office or laboratory decor: Ivory, Wheat yellow, Turquoise, Desert sand, Pale green and Soft gray. Please specify color when ordering.

ORDER NOW

TO: Ultrasonic Industries, Inc., Dept. 13-ICS-3
141 Albertson Avenue, Albertson, L. I., N. Y.

Gentlemen: Please ship ________ DiSONtegrator® System Forty Unit(s) @ $99.95 ea.: ☐ Ivory ☐ Wheat yellow ☐ Turquoise ☐ Desert sand ☐ Pale green ☐ Soft gray

to: ______________________________________

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I understand that my money will be refunded if not completely satisfied after 5 day trial.

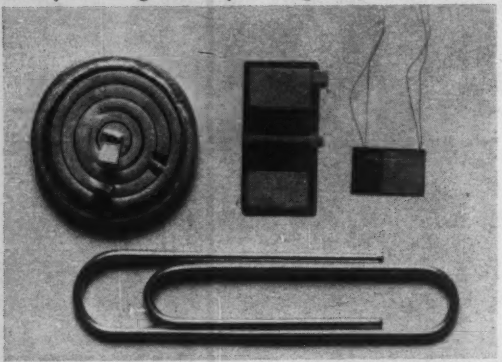
☐ check enclosed (freight prepaid) ☐ C.O.D.
☐ bill me (rated firms only) ☐ Please put us on your mailing list

CIRCLE 24 ON READER-SERVICE CARD

ICS NEWS

Molecular Electronics

PITTSBURGH, PA.—Using solid-state phenomena, it is possible now to create materials having excessive positive or negative electrical charges and, by placing these materials in physical contact with related materials, to bring about such phenomena as rectification or amplification, as in diodes and transistors. Effects of this general type are used in molecular electronic (Moleculonic) blocks by creating (usually in single crystals) a number of distinct operative domains, which can be regarded as molecular "communities" have a common civic purpose, in that each domain will sustain a desired electronic occurrence. The domains border one another at boundaries called interfaces, which can initiate phenomena different from those occurring inside the molecular domains. For example, a domain might be a resistor, the interface a capacitor, etc.



The necessary domains and interfaces are produced by techniques used in the production of conventional semiconductor devices—diffusion, plating, electron beam machining, etching, cutting, radiation, alloying, and photographic processes. The dominant, the essential philosophy of molecular electronics is that we can now create, modify and process materials to endow them with the ability to accomplish electronic tasks through solid-state phenomena.

Illustration shows three of eight available function-block subsystems. At left is an audio amplifier; center is a multivibrator; right is a 2-stage video amplifier. (Courtesy Westinghouse Electric Corp.)

CIRCLE 169 ON READER-SERVICE CARD

Split-Second Spectrometer Used Overseas

CINCINNATI, OHIO.—Chemical reactions that occur in 1/10,000th second are being analyzed by scientists with the aid of a Time-of-Flight Mass Spectrometer at Sweden's famous University of Upsala in a research program on tobacco smoke. The instrument derives its speed from its ability to instantly identify vaporized gases, liquids and solids by revealing their respective molecular masses. Heart of the instrument is an "ion gun," a four-foot metal vacuum tube which pulses ionized (electrically charged) molecules of the elements being analyzed like radar signals from one end of the tube to the other and measures their speed, or "time

Continued on page 320

New! PRESSURE CONTROLLER
TYPE PSC-2

• TWO RANGES!
√ 0.5"-40" Hg. Absolute
√ 0.8"-100" Hg. Absolute

• TWO STYLES!
√ Rack Mounting
√ Separate Case

The Type PSC-2 Pressure Controller is an integrated system which combines an adjustable, highly sensitive mechanical pressure regulator, a micro adjustment, and a servo system. The servo motor precisely adjusts the regulator to desired pressure and compensates for any subsequent drift. A continuous independent indication of the pressure maintained is provided by the Photo Scanner Null Indicator. Rapid traversing between control points is made possible by a unique 3-speed manual control. For servo operation the Controller is used in conjunction with a Hass Photo Electric Barometer. However, the manual control allows its use with a visual sighting barometer or other pressure indicator.

MODEL 2R-40

√ Will establish & maintain a desired pressure within .0005" Hg. or less!

√ Can be manually or servo operated, or both simultaneously!

Other products of The Hass Instrument Corp. include the following: • Type A-1 Barometers & Manometers, precision mercurial, with Temperature Correction & Gravity Compensation, in 3 Ranges (31", 62", & 105" Hg.) • Photo Electric Scanner, PSR-1 (for use with A-1 Barometers & Manometers • Micrometer Standard Barometer, Type MS-2 (a unique, modified U-Tube Primary Pressure Standard available in 2 Ranges: 31" or 62" Hg.) • Automatic & Remote Indicating Barometers • Related accessory equipment for the above instruments (i.e.: Temperature Controlled Cases, Cable Drive & Stop Bar Attachment, etc.) • For more information or special problem application call or write to:

6173 Branch Avenue
Washington 23, D. C.
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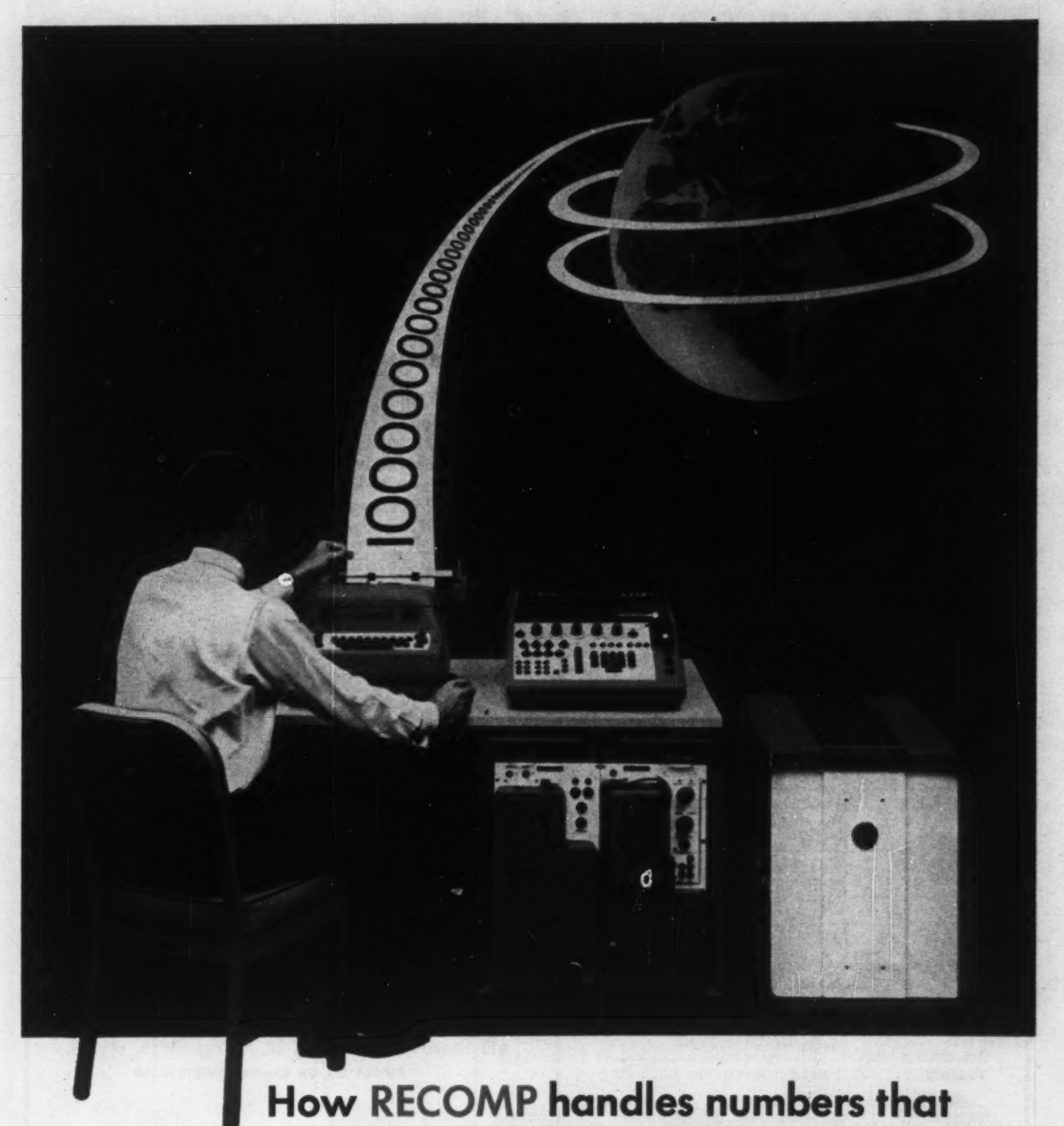
THE HASS INSTRUMENT CORPORATION
Instrument Engineering and Production • Precision Pressure Standards and Controls

CIRCLE 25 ON READER-SERVICE CARD



How RECOMP handles numbers that could circle the world 2½ times

Recomp can handle a floating point number greater than four billion factorial . . . or larger than the figure 1 followed by 41 billion zeros. Typewritten, the number would stretch around the world two-and-one-half times.

Recomp is a low-cost, general purpose, digital computer—the original solid state computer with *proven reliability*. Its built-in floating point arithmetic and square root instructions come as a standard feature among recomp's 49 commands . . . at no extra cost.

Easy to operate, easy to program . . . recomp has a storage capacity of over 8000 instructions, simplified coding, fingertip control console with digital readout panel, and a high-speed photoelectric tape reader.

High-powered recomp is designed to solve problems of engineering, science, and industry. For information on how recomp can solve your special problems, write Autonetics Industrial Products Division, Dept. **603,** 3584 Wilshire Boulevard, Los Angeles 5, California.

Digital computers by Autonetics
INDUSTRIAL PRODUCTS
A DIVISION OF NORTH AMERICAN AVIATION, INC. Other offices: Chicago, New York, Washington, D.C.

AUTOMATIC PRESSURE
or
VACUUM CONTROL J6

UE TYPE J6
PRESSURE
& VACUUM
CONTROL

UNITED ELECTRIC TYPE J6 unit is designed to automatically control either pressure or vacuum . . . has a fixed, uniform on-off differential as specified between limits of 3" WC to 2 PSI . . . and a maximum controlling pressure of 180 PSI. It is a sensitive, weatherproof, precision built control with good repeatability. Recommended for all pressure or vacuum applications which require close on-off differential control.

Switch Differential	Fixed as specified between limits of 3" WC to 2 PSI.
Switch Ratings	15 or 20 amps at 115 or 230 volts AC, also DC switches upon specification.
Switch Types	N.O., N.C., or Double Throw, no neutral position.
Size	4¾" x 4 27/32" x 2 5/16".
Weight	Approx. 1 lb. 8 oz.
Electrical Connection	½" NPT conduit opening in enclosure, screw type terminals on switch is standard.
Enclosure	Die-cast aluminum case, black wrinkle finish standard.
Mounting	Surface mounted—by 2 mounting ears.
Bellows	Seamless brass—spring loaded.
Pressure Connection	¼" NPT female connection.

UNITED ELECTRIC *manufactures a complete line of temperature, pressure and vacuum controls. UE will gladly modify or custom-build a unit to your specifications. Consult a UE application engineer today.*

Write for Bulletin No. 5-3 for complete J6 data.

United Electric Controls
COMPANY
SCHOOL STREET WATERTOWN

CIRCLE 26 ON READER-SERVICE CARD

of flight" electronically. A spectrum then appears on an oscilloscope. Spectrometers of this kind are also being installed at the University of Goettingen in West Germany and at England's University of Birmingham. The spectrometers are made by Bendix Aviation Corp., Cincinnati Div., 3130 Wasson Rd., Cincinnati 8, Ohio.

CIRCLE 170 ON READER-SERVICE CARD

Radar Display Computer

NEW YORK, N. Y.—An advanced radar tracking display computer the MC-555-A, which operates with all operational radars has recently completed its first 1000 hours of operation at the Wallops Island range of NASA. The system is designed to provide data in Cartesian coordinate form to permit display of the path of a radar tracked object on an X-Y plotting board.

Heart of the computer are the operational amplifiers with a gain of 100 x 10^6, output of ±100v, phase shift of less than 0.2 degrees, operating noise level less than 1 mv rms, and recovery from overload of less than 1.0 seconds. All operational amplifiers are dual-channel, plug-in units. A completely automatic test circuit incorporated in the design assures trouble free operation. Computer Systems, Inc., (formerly, Mid-Century Instrumatic Corp.) 611 Broadway, New York 12, N. Y. built the system.

CIRCLE 171 ON READER-SERVICE CARD

A new electronic supervisory control system, designed and built by **Southwestern Industrial Electronics Co.,** a division of Dresser Industries, Inc., 10201 Westheimer, Houston, Texas, is being installed for the Phillips Petroleum Co. on a 20-well lease in one of its Lake Maracaibo, Venezuela operations. It provides control for remote and local well testing and production.

CIRCLE 172 ON READER-SERVICE CARD

JONES & LAUGHLIN STEEL CORP. in the near future will install a special-purpose electronic computer in its Aliquippa, Pa. works to speed calculations in basic oxygen steelmaking. It will furnish the operator with the proper portions of scrap, fluxing materials, and hot metal to be charged into the furnace for temperature control purposes.

SPECIFY BARTON INSTRUMENTS

For field proven quality

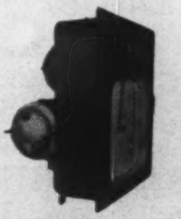
in the measurement of

FLOW
LIQUID LEVEL
DIFFERENTIAL PRESSURE

MODEL 199
Differential Pressure Unit
BULLETIN 199-1

MODEL 200
Differential Pressure Indicator
BULLETIN 200-1

MODEL 202
Differential Flow Recorder
BULLETIN 202-1



MODEL 208
Dual Flow Recorder
BULLETIN 208-1

MODEL 211
Indicating Diff. Press. Switch
BULLETIN 211-2

MODEL 214
Indicating Pneumatic Transmitter
BULLETIN 214-3

MODEL 233
Indicating Diff. Press. Switch—Explosion Proof
BULLETIN 233-1

MODEL 234
Indicating Diff. Press. Switch
BULLETIN 234-2

MODEL 237
Diff. Press. Pneumatic Controller
BULLETIN 237-2

MODEL 243
Pressure Compensated Integrating Flow Recorder
BULLETIN 243-2

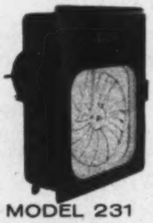
MODEL 252
Integrating Flow Recorder
BULLETIN 252-1

MODEL 224
Differential Pressure Unit
BULLETIN 224-2

MODEL 225
Indicating Pneumatic Transmitter
BULLETIN 225-1

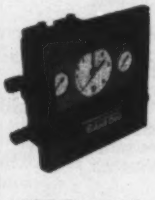
MODEL 226
Differential Pressure Indicator
BULLETIN 226-2

MODEL 227
Differential Pressure Indicator
BULLETIN 227-1

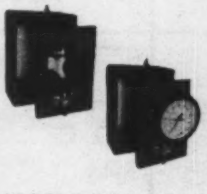


MODEL 231
Differential Pressure Recorder
BULLETIN 231-1

MODEL 232
Indicating Diff. Press. Switch
BULLETIN 232-1



MODEL 240
Diff. Press. Pneumatic Controller
BULLETIN 240-1



MODELS 246 & 247
Portable Flow Indicators
BULLETIN 246-1

MODEL 248
Indicating Diff. Press. Switch
BULLETIN 248-1

FOR NEW CATALOG OR PRODUCT BULLETINS, PLEASE WRITE, DEPT. M.

BARTON INSTRUMENTS

Representation in Principal Cities Throughout the Free World

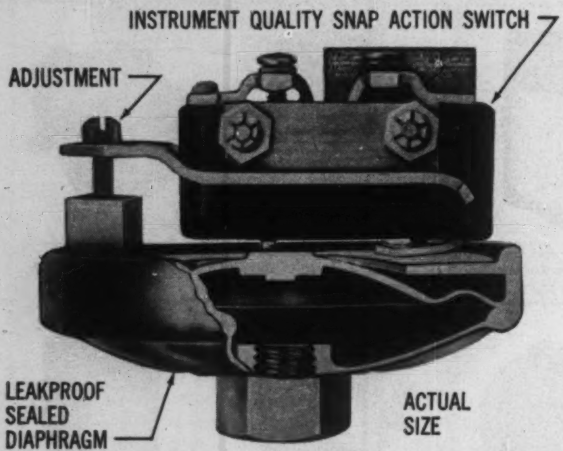
BARTON, INSTRUMENT CORPORATION
580 MONTEREY PASS ROAD • MONTEREY PARK, CALIFORNIA

CIRCLE 27 ON READER-SERVICE CARD

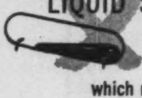
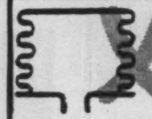
NEW PRESSURE SWITCH FOR THE **O.E.M.**

This *stripped* switch is designed specifically for the Original Equipment Manufacturers who enclose the various controls in a common cabinet. This new pressure and vacuum switch model 402, incorporates the same dependable accuracy and other operating features of the proven *housed* model 420.

Cost and price have been cut by eliminating the housing.


INSTRUMENT QUALITY SNAP ACTION SWITCH
ADJUSTMENT
LEAKPROOF SEALED DIAPHRAGM
ACTUAL SIZE

HERE'S THE SIMPLEST DIAPHRAGM PRESSURE SWITCH

WE BUILD IN	WE DON'T USE
EXTREME ACCURACY and DEPENDABILITY maintained during operating life due to direct acting design	 LINKAGE and BEARINGS which, as they wear, make the setting of the pressure switch drift.
EFFICIENT OPERATION IN ANY POSITION which saves the installation costs encountered in mounting a switch that uses liquid switching elements	 LIQUID SWITCHING ELEMENTS which make the switch difficult to mount and very critical to vibration.
IMMUNITY TO VIBRATION you can mount the switch directly on your vibrating or moving equipment.	 ACCORDION BELLOWS which make the pressure switch sensitive to vibration.

Ask for new catalog '59-'60

PRESSURE SWITCH DIVISION

barksdale valves

5125 ALCOA AVENUE • LOS ANGELES 58 • CALIFORNIA

CIRCLE 28 ON READER-SERVICE CARD

BRIEFS

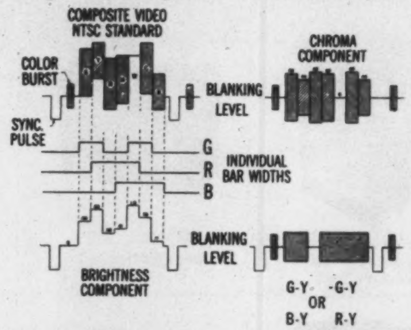
Linear Programmed Chromatograph

The F&M Chromatograph, by linearly increasing the column temperature during a run, separates components with boiling points ranging up to 450°C and records them as well-defined sharp peaks of nearly the same shape. Time of analysis and degree of separation can be adjusted by selecting any combination of nine available linear heating rates . . . The major advantage of the linear programmed temperature technique over that of constant temperature operation is . . . that all the peaks were well resolved and easy to measure, and that the reproducibility of peak height, peak area, and retention time in the duplicate run was excellent . . . (*From new 4-page M-H Instrumentation data sheet* 10.15-20, *F & M Scientific Corp.,* 1202 *Arnold Ave., New Castle County Airport, New Castle, Del.*)

FOR THIS LITERATURE CIRCLE 162 ON READER-SERVICE CARD

Television Generators

The Model 656XC provides signal for complete color alignment. Produces color bars on TV screen in the following order from left to right: green, yellow, red, magenta, white, cyan, blue and black. Phase of color produced is accurately set with precision delay lines. The amplitude of sub-carrier and the amplitude of the brightness component are accurately set with precision resistive Networks. This results in the high stability required for proper alignment. Proper colors are generated within 30 seconds after warmup. In addition to color bar patterns, the 656XC produces: White Dot crosshatch (20 vertical and 15 horizontal, less those in blanking); Vertical Lines only; Horizontal Lines only; and small size WHITE DOTS are "locked" to assure stability. This "locking" is achieved through the self generated 60 cycle and 15,750 cycle sync pulses. The white dots are of perfect size (approx. 2 lines thick) to permit accurate convergence adjustments. 300 dots are present in each raster, less those in the blanking region . . . (*From new 16-page Catalog 38 "Electrical Electronic Testing Equipment," Hickok Electrical Instrument Co.,* 10514 *Dupont Ave., Cleveland 8, Ohio.*)

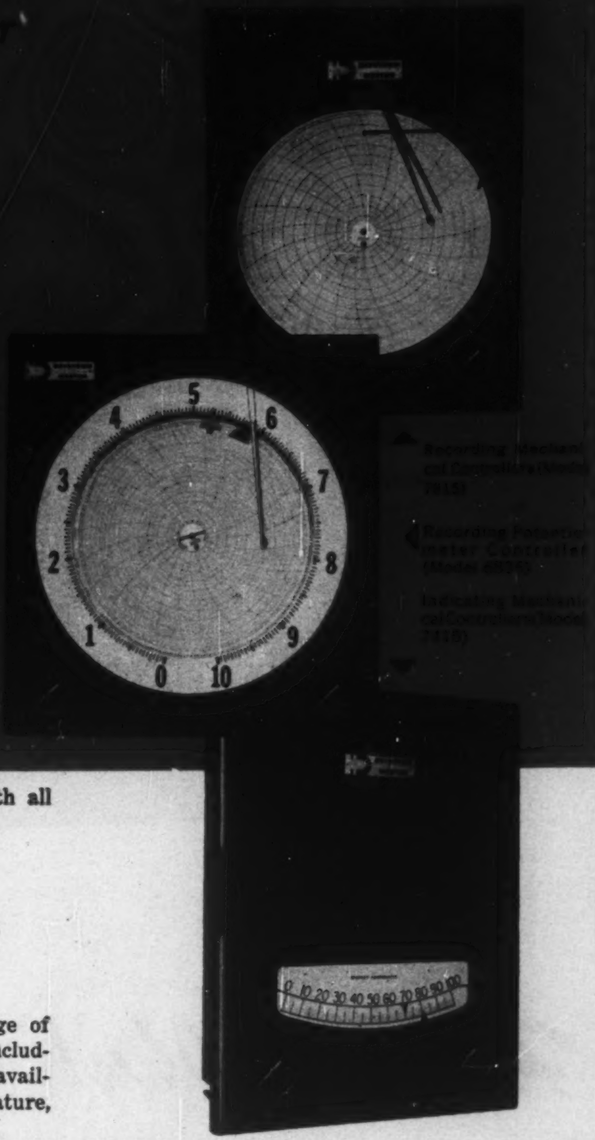


FOR THIS LITERATURE CIRCLE 163 ON READER-SERVICE CARD

When your process calls for

PRECISE, VERSATILE CONTROL

Choose from the DAYSTROM-WESTON complete family of recording and indicating pneumatic controllers



Recording Mechanical Controllers (Model 7815)

Recording Potentiometer Controller (Model 6834)

Indicating Mechanical Controllers (Model 7815)

Each of these advanced instruments is available with all varieties of pneumatic control:

1. Universal: 2-50% proportional band; on-off; and 2-100% differerential gap, manual reset
2. Proportional (2-300%) with automatic reset
3. Proportional (2-300%) with automatic reset plus derivative.

The mechanical instruments cover the complete range of filled thermal systems, pressure spirals and bellows, including pneumatic receivers, interchangeably. Ranges are available as low as —100F. and as high as 1000F. for temperature, and 30" vacuum to 10,000 psi for pressure.

The unitized potentiometer instruments feature plug-in amplifiers, easily interchangeable range standards and slide wires. Constant current is supplied by the D-PAK (T.M.)—Daystrom-Weston's revolutionary solid-state unit which eliminates battery, standard cell, and other standardizing mechanisms.

All models come in dust and moisture-resistant cases and are for universal mounting. They are ruggedly constructed for long life and trouble-free service—and for resistance to vibration and shock. Internal construction is unusually clean in design, and provides easy accessibility to all parts.

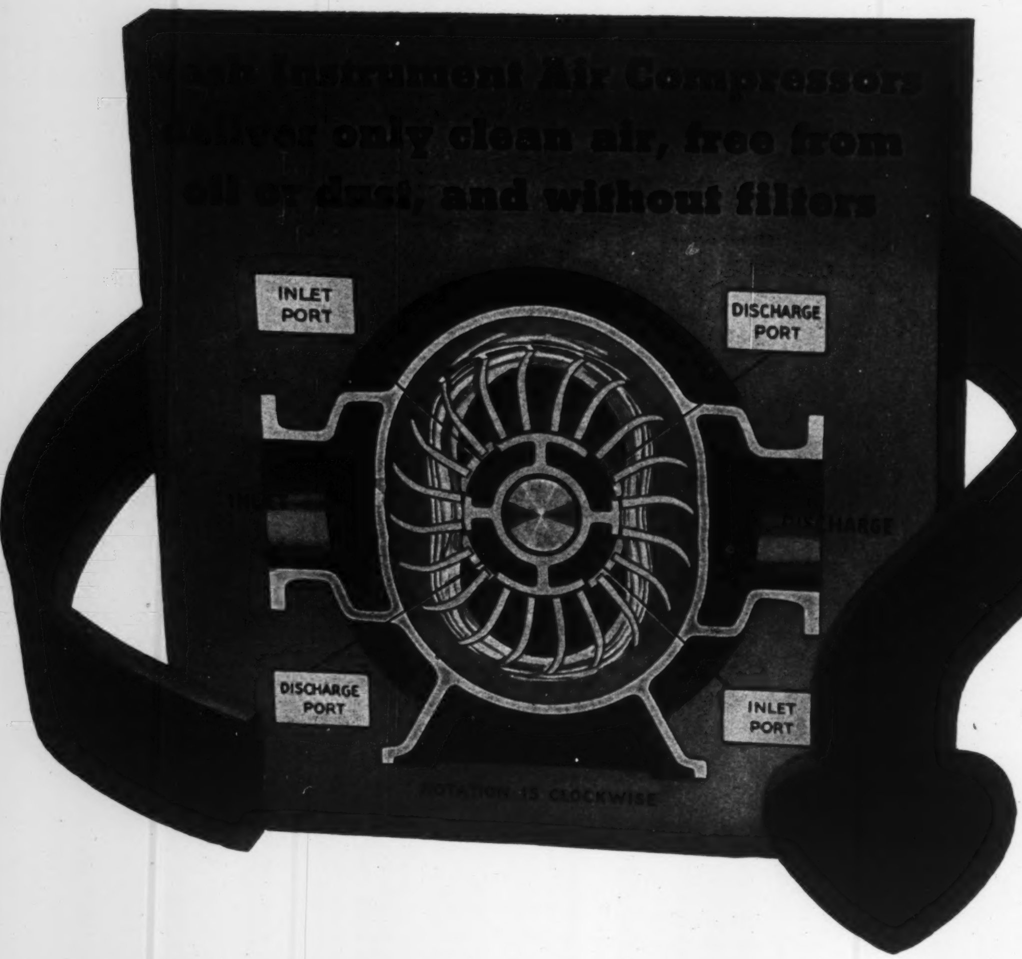
For full information, contact your local Weston representative, or write to Daystrom-Weston Sales Division, Newark 12, N. J. *In Canada: Daystrom Ltd., 840 Caledonia Rd., Toronto 19, Ont. Export: Daystrom Int'l., 100 Empire St., Newark 12, N. J.*

DAYSTROM WESTON

World leader in measurement and control

DAYSTROM-WESTON INDUSTRIAL INSTRUMENTS include a full line of recording and controlling potentiometers with strip and circular charts; mechanical recorders and indicators for pressure, temperature and flow; and non-indicating controllers, both electric and pneumatic.

CIRCLE 29 ON READER-SERVICE CARD


Nash Instrument Air Compressors deliver only clean air, free from oil or dust, and without filters
INLET PORT
DISCHARGE PORT
INLET
DISCHARGE
DISCHARGE PORT
INLET PORT
ROTATION IS CLOCKWISE

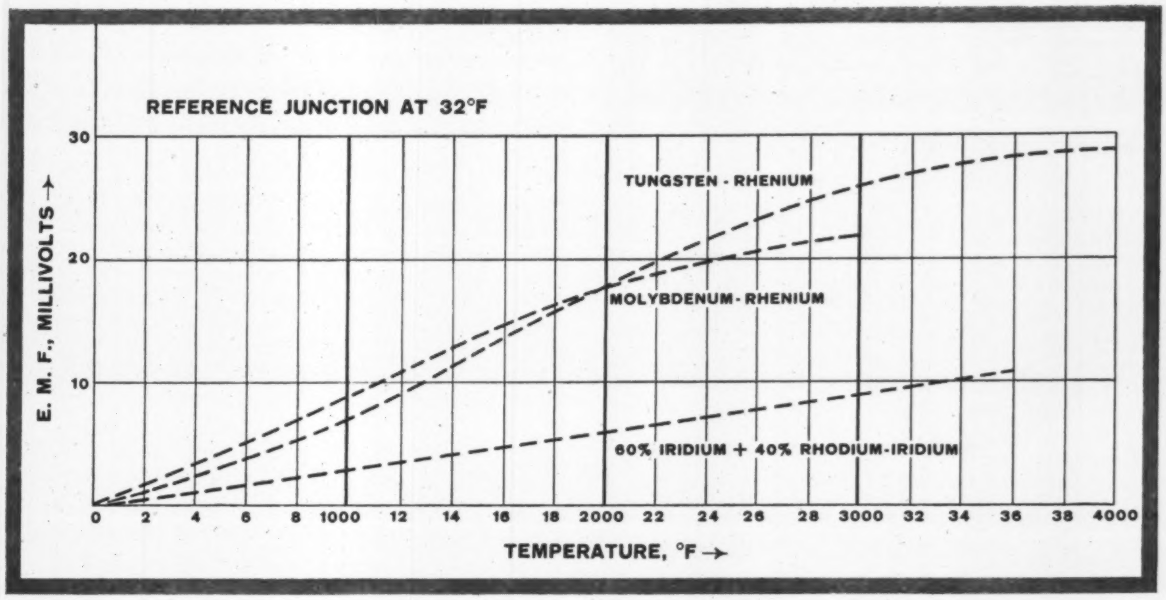
Here is Why!

You can dispense with oil filters and dust filters when you install ®Nash® Clean Air Compressors. You can save the cost of maintaining these devices. You can greatly reduce instrument maintenance costs. For the Nash employs no internal lubrication, therefore no troublesome oil is in the delivered air. Moreover, air from a Nash is thoroughly washed and cooled as it passes thru the pump. Dust in the plant atmosphere, even fly ash, is immediately removed.

®Nash® Clean Air Compressors are simple, with only one moving element. No valves, gears, pistons, sliding vanes, or other enemies of long life and constant performance complicate a Nash. No aftercoolers are needed. You will find it profitable to investigate these pumps, now.

No oil filters.
No dust filters.
No internal lubrication to contaminate air handled.
No internal wearing parts.
No valves, pistons, or vanes.
Non-pulsating pressure.
Original performance constant over a long pump life.
Low maintenance cost.

NASH ENGINEERING COMPANY
370 WILSON, SO. NORWALK, CONN.



Measure temperatures up to 4000°F with Honeywell Thermocouples

Precise measurement of high temperatures is almost an art. Working effectively with temperatures over 2800°F calls for an intimate knowledge of both materials and methods. Honeywell's long experience, combined with an intensive basic research program, have produced special techniques and equipment for precise measurement of high temperatures.

The thermocouples listed below—tungsten-rhenium, molybdenum-rhenium, and 60% iridium + 40% rhodium-iridium—are the best available combination of calibration stability, reproducibility and physical strength. Although the temperature-emf curves shown above are still tentative, they are based on substantial scientific studies conducted independently in several different laboratories.

Honeywell's research at the Hopkins Research Center is aimed at discovering more and more practical information on high-temperature thermocouples and passing the results on to you.

For more information, call your Honeywell Field Engineer . . . he's as near as your phone.

MINNEAPOLIS-HONEYWELL, Wayne and Windrim Avenues, Philadelphia 44, Pa.

Honeywell

H *First in Control*
SINCE 1885

*HIGH TEMPERATURE ASSEMBLIES WITH PROTECTING TUBE**

Calibration	Maximum Recommended Temperature	Tube & Insulator Material	Tube Dimensions I.D. (in.)	Tube Dimensions O.D. (in.)
TUNGSTEN-RHENIUM	3200°F 4000°F	ALUMINUM OXIDE BERYLLIUM OXIDE	3/16 1/4	5/16 3/8
MOLYBDENUM-RHENIUM	3000°F	ALUMINUM OXIDE	3/16	5/16
60% IRIDIUM+ 40% RHODIUM-IRIDIUM	3200°F 3600°F	ALUMINUM OXIDE BERYLLIUM OXIDE	3/16 1/4	5/16 3/8

*HIGH TEMPERATURE ASSEMBLIES WITHOUT PROTECTING TUBE**

Calibration	Maximum Recommended Temperature	Insulator Material	Insulator Dimensions I.D. (in.)	Insulator Dimensions O.D. (in.)
TUNGSTEN-RHENIUM	3200°F 4000°F	ALUMINUM OXIDE BERYLLIUM OXIDE	0.028 0.028	0.140 0.130
MOLYBDENUM-RHENIUM	3000°F	ALUMINUM OXIDE	0.028	0.140
60% IRIDIUM+ 40% RHODIUM-IRIDIUM	3200°F 3600°F	ALUMINUM OXIDE BERYLLIUM OXIDE	0.028 0.028	0.140 0.130

*Most assemblies available in 5", 11", 17", 20", 23" and 29" immersion lengths.

CIRCLE 81 ON READER-SERVICE CARD

New—EASY PANEL MOUNTING

0
10
10
20
20
30
30
40
40
50
50

MID-WEST
DIFFERENTIAL
GAUGES

Offer These
Plus Features

- 4,000 psi Working Pressure
- Encapsuled Bourdon Tube Element
- Easy Panel Mounting
- Light Weight Aluminum Case
- Standard and Precision Types

Mid-West's Encapsuled Bourdon Tube Element introduces a new concept in differential pressure gauges. New jewelled bearing movement assures magnetic transmission of Bourdon Tube motion—with extremely low hysteresis and tracking error. Dial ranges from 100 in. H_2O to 400 PSI differential.

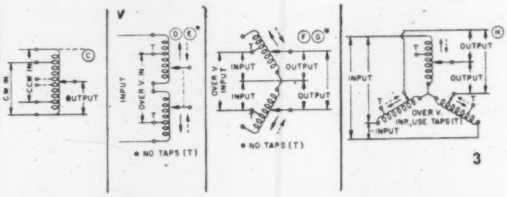
MID-WEST INSTRUMENT DIV.,
ASTRA ASSOCIATES, INC.
1021 E. State Fair, Detroit 3, Michigan
Tel: TWinbrook 3-8250

CIRCLE 31 ON READER-SERVICE CARD

BRIEFS—CONTINUED

Variable Transformers

Ohmite "v.t." transformers are unique as a result of the design innovations they incorporate. These include exclusive field-proven features (such as) positive current transfer achieved . . . by means of a pigtail directly connecting the brush to the large slip-ring which contacts a wide area of the collector ring.



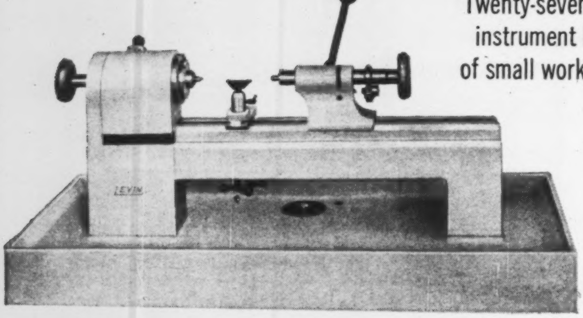
On all units with overvoltage feature either overvoltage or no-overvoltage output can be arranged on the terminal panel. On VT4 and VT8 transformers connected for over-voltage, either clockwise or counterclockwise increase of voltage can be arranged quickly by the user. Increasing voltage in either direction can be arranged on all units connected for no-overvoltage output. Two-in-tandem assemblies may be wired for individual unit operation or as follows: (1) series connection for 1-phase input at a line voltage double that of the individual transformer's input rating—with or without overvoltage output or open delta connection . . . (*From new 8-page Bulletin 151D, Ohmite Manufacturing Co.* 3601 *Howard St., Skokie, Ill.*)

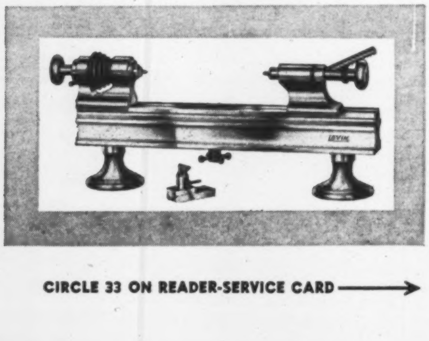
FOR THIS LITERATURE CIRCLE 164 ON READER-SERVICE CARD

ARE YOU PROPERLY GEARED FOR
MINIATURIZATION?

LEVIN INSTRUMENT LATHES
PRODUCE SMALL INSTRUMENT PARTS BETTER

Twenty-seven models of instrument lathes for all types of small work. Collet capacity 5/16″ or 3/16″. Levin Instrument Lathes are used wherever fine work is being done. Over 11,000 lathes in use.





For complete details of Levin Instrument Lathes and accessories send for catalog T.

Louis Levin & Son, Inc., 3610 So. Broadway, Los Angeles 7, Calif.

CIRCLE 32 ON READER-SERVICE CARD

CIRCLE 33 ON READER-SERVICE CARD ⟶

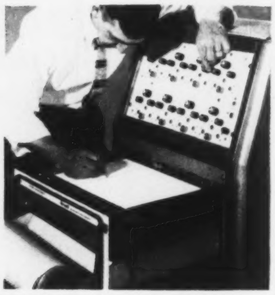
this is the Brush Mark II . . . anyone can plug it in put it in writing anywhere

brush
RECORDER MARK II
power
pen bias
pen bias
sensitivity
sensitivity
volts/chart line
volts/chart line
chart speed
BRUSH INSTRUMENTS
ground input
ground input

There is no direct writing recorder on the market that approaches the compact Mark II in sheer usefulness. It is a completely integrated engineering tool that can be operated by anyone . . . in the shop or in the field . . . for countless research or design requirements. Every function necessary for uniform, crisp, easily reproduced readouts is "built-in". The Mark II gives you two analog channels plus two event markers; 4 chart speeds; DC to 100 cps response with 40 mm amplitude; 10 mv/mm sensitivity; high input impedance. Immediate shipment from stock. Call, write or wire for complete details.

brush INSTRUMENTS
DIVISION OF
37TH AND PERKINS CLEVITE CORPORATION CLEVELAND 14, OHIO

for direct writing recording systems no one is as qualified as Brush



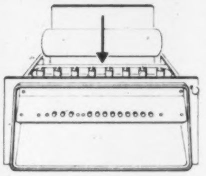
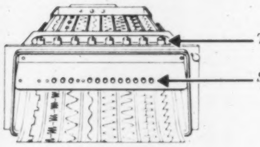
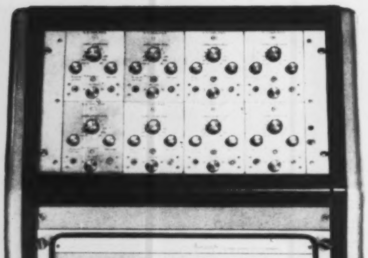


Chart paper loads from top





Why? Simply because Brush recording systems such as this 6-8 channel unit incorporate all of the known refinements in the art of recording by direct writing. No comparable system in existence today is as compact . . . as simplified . . . as reliable . . . as versatile. Note slide-mounted oscillograph and interchangeable "plug-in" signal conditioners that provide four vital functions in addition to amplification: high input impedance, zero suppression, attenuation and calibration.

Instantaneous rectilinear presentation gives clear, uniform and reproducible traces for precise readout of telemetry, computer, ground control and other data gathering operations. Further, this functionally designed system has a "pull-out" horizontal writing table for convenient annotation and reading . . . without turning off the recorder! Check these and many other advanced features for yourself and you'll see why *no one* is as qualified as Brush. Call, write or wire for complete details.

brush INSTRUMENTS
DIVISION OF
37TH AND PERKINS **CLEVITE** CORPORATION CLEVELAND 14, OHIO

Digital Readout Oscilloscope

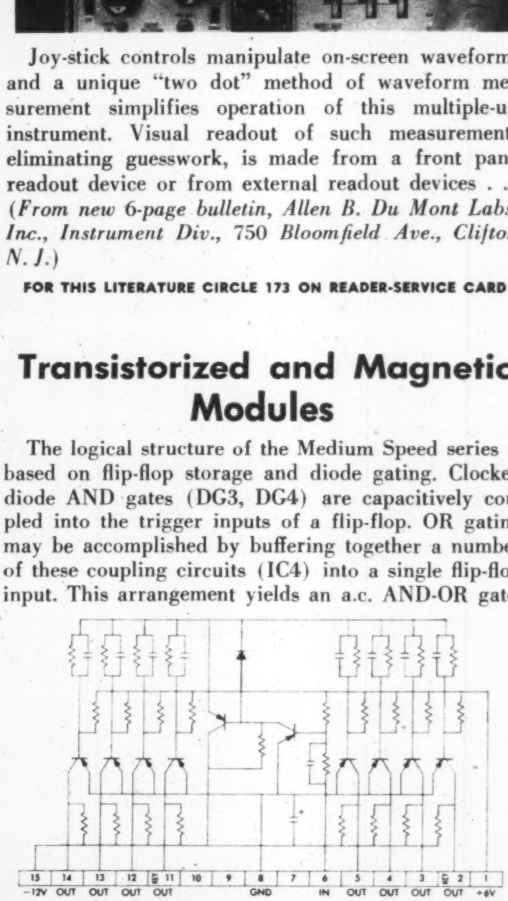
The Type 425 is fundamentally a 35 megacycle, modularized, versatile, general-purpose high-frequency oscilloscope. The instrument includes a new Readout system which may be used as an analog to digital converter. The versatility of the oscilloscope is established through the use of three basic types of plug-ins which supply circuitry for delaying sweep, dual-trace investigations and X-amplification. Numerous other plug-ins, as they continually become available, will extend the frequency range and versatility even further without obsoleting any portion of the equipment.

Joy-stick controls manipulate on-screen waveforms, and a unique "two dot" method of waveform measurement simplifies operation of this multiple-use instrument. Visual readout of such measurements, eliminating guesswork, is made from a front panel readout device or from external readout devices . . . (*From new 6-page bulletin, Allen B. Du Mont Labs., Inc., Instrument Div.,* 750 *Bloomfield Ave., Clifton, N. J.*)

FOR THIS LITERATURE CIRCLE 173 ON READER-SERVICE CARD

Transistorized and Magnetic Modules

The logical structure of the Medium Speed series is based on flip-flop storage and diode gating. Clocked diode AND gates (DG3, DG4) are capacitively coupled into the trigger inputs of a flip-flop. OR gating may be accomplished by buffering together a number of these coupling circuits (IC4) into a single flip-flop input. This arrangement yields an a.c. AND-OR gate.



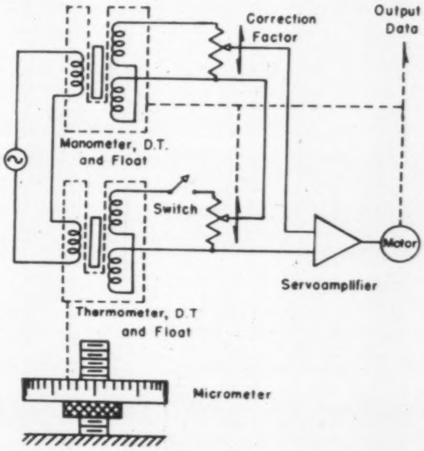
← CIRCLE 34 ON READER-SERVICE CARD

The diode gate modules may be combined directly to form d.c. AND-OR gates. Emitter Followers (EF1) are provided to operate from the high output impedance of the cascaded d.c. gates. For complex logical functions, the d.c. and a.c. gates may be cascaded to form an AND-OR-AND-OR network . . . (*From new folder containing* 10 *sheets describing and specifying* 20 *modules, Packard Bell Computer Corp.,* 1905 *Armacost Ave., Los Angeles* 25, *Calif.*)

FOR THIS LITERATURE CIRCLE 174 ON READER-SERVICE CARD

Servomanometers

Exactel Servomanometers prove useful in the physical measurements field by combining the precision of the manometer with modern servo-following techniques. The Exactel instrument has introduced Analog Temperature Compensation, and has the ability to use any liquid, optional use of stainless-steel manometer tubes, and other unique capabilities which have greatly increased the precision and broadened the application of the manometer principle . . .

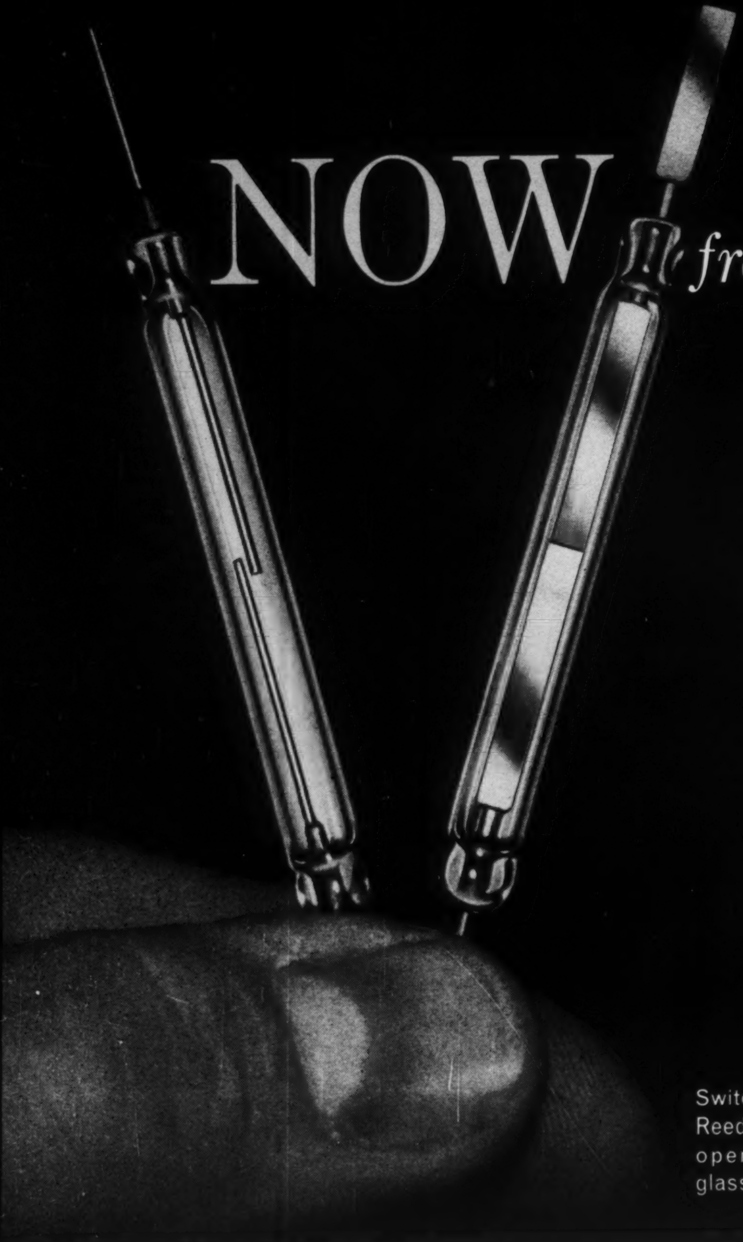


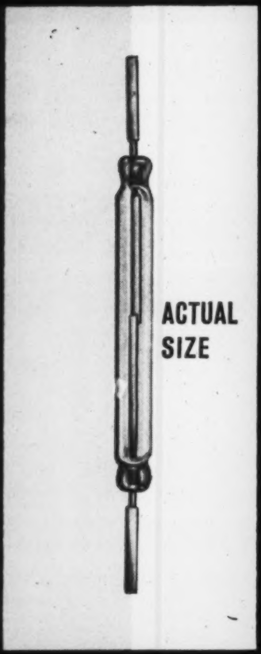
The new, economic industrial instrument series is designed for general application in the power generating and other industrial fields for applications that do not require the maximized accuracy of the precision series . . .

The float operates within the AC field of the differential transformer which induces a vibration of a few micro-inches amplitude. The vibration eliminates hysteresis and there is considerable evidence that there is improvement of the meniscus form itself. Also, the float responds to the center of the meniscus . . . (*From new 16-page Bulletin* 500 —1959 *Edition and General Price List, Exactel Instrument Co.,* 5545 *Eva Ave., Los Angeles, Calif.*)

FOR THIS LITERATURE CIRCLE 175 ON READER-SERVICE CARD

NOW *from C.P. Clare & Co....*





Switch capsule of the new Clareed Sealed Contact Reed Relay consists of a pair of magnetically operated contacts, hermetically sealed in a glass capsule, in an atmosphere of inert gas.

SPECIFICATIONS

Contact Arrangement: Normally form A, form B, in combination form C

Overall length: 3-¼ in. max.

Outside diameter: 0.215 in. max.

Contact material: Gold

Contact rating: 15 volt-amperes max., non-inductive: 1 amp. max.; 250 volts max.

Contact resistance: 25-40 milliohms.

Life expectancy: At 14 volt-amperes (½ ampere, 28 volts dc), 20,000,000 operations.
At 7 volt-amperes (¼ ampere, 28 volts dc), 100,000,000 operations.

Minimum breakdown voltage: (60 cps) 500 volts rms.

Insulation resistance: 500 k megohms min.

Low level load test: 8 microamps, 800 ohms, 250 millivolts, open circuit operated at 3 ips, 100 million operations with no failures.

		Milliseconds (including bounce)		
		Operate Excess NI over P.U.		
Switches per Coil	Watts to Just Operate Typical Coils	100	200	Release
1	0.25	1	0.8	0.25
2	0.30	1.5	0.9	0.25
3	0.35	2.2	1.5	0.25
4	0.42	3.2	2.2	0.25
5	0.52	3.5	2.5	0.25
6	0.8	5	3.5	0.50
12	1.5	6	5	0.50
20	3.5	8	6	0.50

CONTACT BOUNCE		
	At "just operate"	0.3 ms max.
	At 200 excess NI	0.5 ms max.
	At 400 excess NI	0.8 ms max.
	No bounce on release.	

...

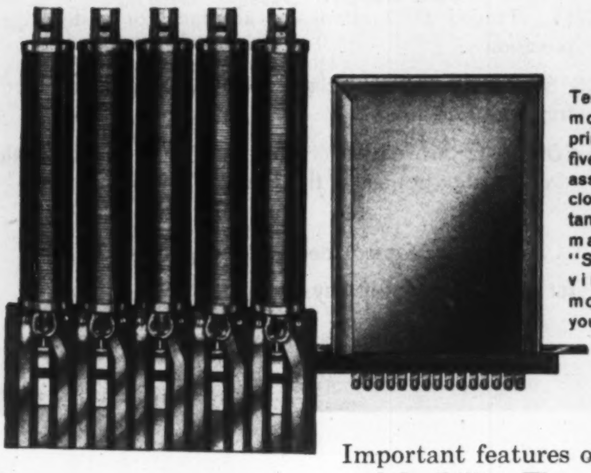
CLAREED®

a New Concept in Relay Design

The new CLAREED Sealed Contact Reed Relay effectively eliminates contact contamination. With its contacts hermetically sealed in contaminant-free inert gas, this new design assures millions of perfect operations. Hundreds of millions are possible when operated at up to ½ rated contact load.

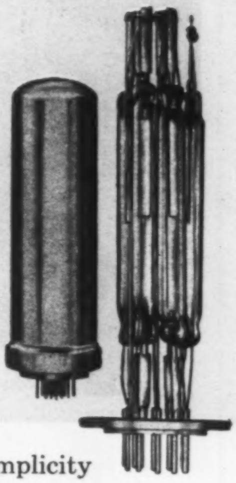
CLAREED relays are ideal components for transistor drive applications and for use in computers and data processing equipment. Their low inductance and the low inductance change in the operating coil at each operation limits the transients produced. Submit your packaging problem for recommendations.

• PACKAGED TO MEET *your* REQUIREMENTS



Ten CLAREED switches, mounted in line on a printed circuit board with five magnetic coils. This assembly can then be enclosed in the flat, rectangular container or it may be coated with "Skin-Pack," a tough vinyl plastic, and mounted directly into your equipment.

Six CLAREED switches clustered for mounting in a single tube container.



Important features of CLAREED relays are their simplicity and flexibility. They may be mounted to meet the requirements of almost any application and environmental condition, even on your own printed circuit board—to comply with your mechanical design configurations.

CLAREED relays are as flexible as your application requires. Consultation with your nearby CLARE sales engineer is invited. Additional information may be obtained from C. P. Clare & Co., 3101 Pratt Blvd., Chicago 45, Illinois. In Canada: C. P. Clare Canada Limited, Box 134, Downsview, Ontario. Cable Address: CLARELAY. *Send for Bulletin CPC 5.*

SEE IT AT THE IRE SHOW

New York Coliseum
March 21-24

BOOTH NOS. 2218 & 2220

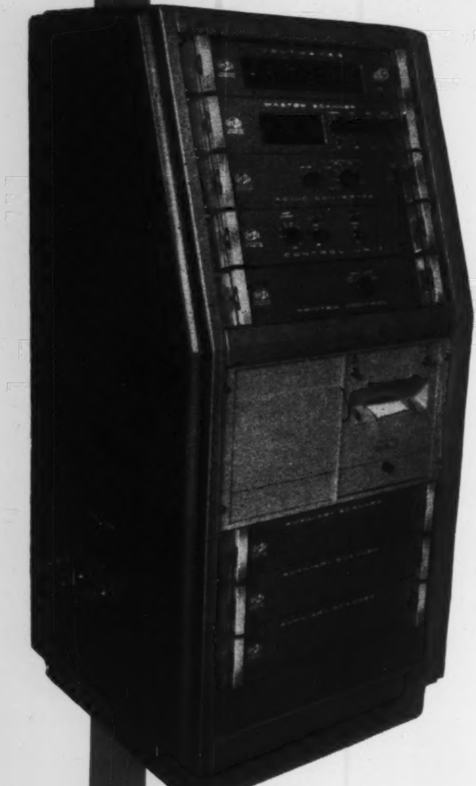
CLARE FIRST in the industrial field

CIRCLE 35 ON READER-SERVICE CARD

SEE... and HEAR...

THE DIGITAL SYSTEMS THAT SPEAK FOR THEMSELVES!

At New York IRE: In practical application for industrial process control.



From the field, from a proved capability, Cubic's fine precision laboratory instrumentation is applied to the automation of industrial processes and given hitherto unknown dimensions with a "readout" you can *hear*.

In the field and at IRE,
Cubic Digital Systems speak for themselves . . .

DC VOLTMETER: Proved stability of .003% and noise rejection as high as 200%

AC CONVERTER: Proved operation to 90 kc, with accuracy exceeding specifications

OHMMETER: Proved shock-safe with controlled open-circuit test voltage

RATIOMETER: Proved .003% attenuator accuracy for wide-range precision

SCANNING SYSTEMS: Proved reliability over weeks of automated transistor sampling

PRINTER CONTROL: Proved performance in data recording with every quality printer on the market.

. . . And the human-engineered Talking Meter,
for a vocal readout in any parameter.

When you're at New York IRE, stop by Cubic's booth and see the unique Weather Board monitored by a Cubic Digital System to give you the weather story across the nation . . . in digital and vocal report.

BOOTH 3235

Years-ahead engineering, factory production techniques inspired by pride in the end result, careful quality control and reliability testing . . . all these factors make Cubic's the truly fine instrumentation . . . Digital Systems that speak for themselves.

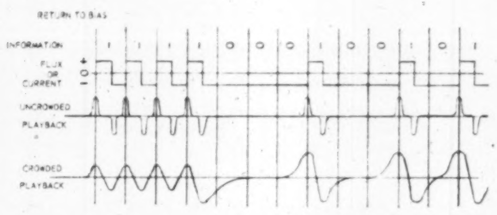
CUBIC CORPORATION
INDUSTRIAL DIVISION
5575 Kearny Villa Road, San Diego 11, California
Electronic Engineering With a Dimension for the Future

CIRCLE 36 ON READER-SERVICE CARD

Pulse Magnetic Recording

In order to record information on a magnetic medium, an H field must be produced which will cause a portion of that medium to become magnetized . . .

In order to record narrow pulses, four conditions are required: (1) A gap that is much narrower than the smallest wave length to be recorded . . . (2) A space that is about the same or smaller than the gap . . . (3) Coatings that are thin compared to the gap length . . . and (4) Coating material with essentially a square hysteresis loop . . .

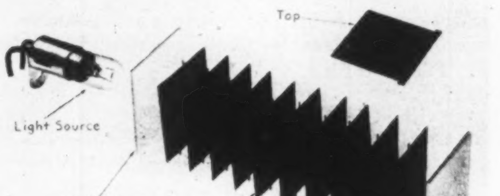


Binary representation of alpha-numeric information (numbers and letters) is the most commonly used scheme in computer work . . . Three common recording schemes are: *Return-to-bias* (RB) method; *Non-return-to-zero* (NRZ) method; *Phase Modulation* (PM) system . . . (*From new 12-page Bulletin CPD 130-SA, Bryant Computer Products Div., Box 620, Springfield, Vt.*)

FOR THIS LITERATURE CIRCLE 176 ON READER-SERVICE CARD

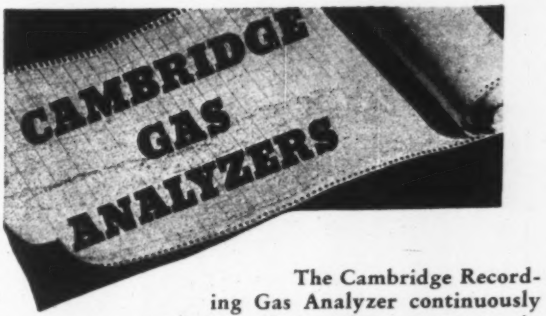
Slide Plate Readout

The Slide Plate accepts Binary Coded Decimal (BCD) input and displays alpha-numeric characters. This means that the unit does its own translating and does not need auxiliary translators, relays, or diodes. It will accept any BCD or teletype code up to 6 bits, do its own translating, and display the proper character . . .



The Slide Plate stores and displays the last signal entered into it until commanded to accept and display a new signal input . . . In other works, the Slide Plate contains its own memory storage . . . (*From new 8-page Editorial Release, Industrial Electronic Engineers Inc., 5528 Vineland Ave., North Hollywood, Calif.*)

FOR THIS LITERATURE CIRCLE 177 ON READER-SERVICE CARD



The Cambridge Recording Gas Analyzer continuously analyzes and records as many as six constituents of a gas. Eliminates intermittent, slow and expensive manual gas analysis. Accurate . . . Sensitive . . . Simple. No moving parts; utilizes thermal conductivity principle.

Makes possible substantial savings in the operation of kilns, production of inert gases, and in metallurgical, petroleum, and other chemical processes. Single- and Multi-point instruments are available for a wide variety of applications.

Send for literature mentioning application

CAMBRIDGE
INSTRUMENT COMPANY, INC.
3554 Grand Central Terminal, New York 17
Pioneer Manufacturers of
PRECISION INSTRUMENTS

CIRCLE 37 ON READER-SERVICE CARD

NO TEMPERATURE OVERSHOOT

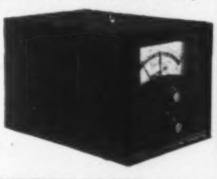
WHEN SIMPLYTROL MINDS THE POT

time-proportioning controller has unique anticipating action

Low-cost Simplytrol gives you high-accuracy temperature control . . . effectively maintains temperature to within ± 1°F. of set point on most applications. An ingenious anticipating circuit eliminates overshoot difficulties by shutting off heat input at a time-proportioned interval before the set-point temperature level is attained.

Built around the well-proven A.P.I. meter-relay design, Simplytrol uses no amplifying circuits or vacuum tubes; it is exceptionally stable and reliable. The unit is available in thirty ranges from —400°F. to +3000°F., is packaged in a newly re-styled table-mounting case that converts in minutes to panel mounting.

SEND FOR DATA SHEET 9-B

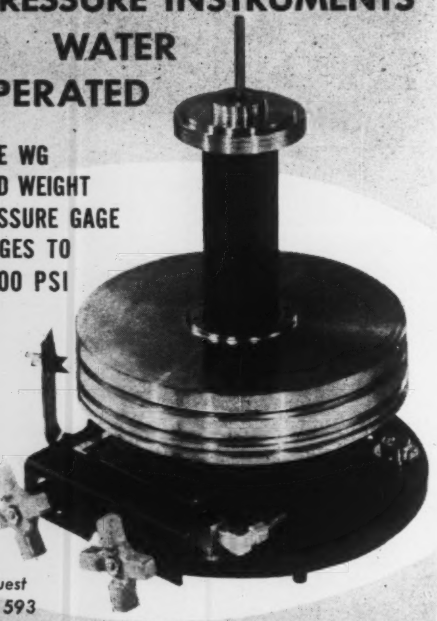


ASSEMBLY PRODUCTS, INC.
Chesterland 10, Ohio
S.A., 1913

CIRCLE 38 ON READER-SERVICE CARD

NO CONTAMINATION
OF PRESSURE INSTRUMENTS
WATER
OPERATED

TYPE WG
DEAD WEIGHT
PRESSURE GAGE
RANGES TO
13,000 PSI

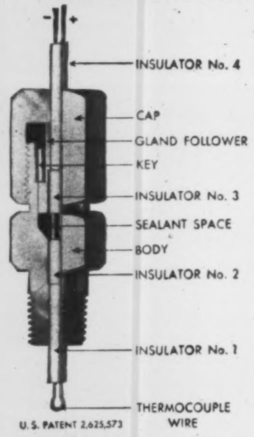


Please request
data sheet 593

MANSFIELD & GREEN INC.
1051 POWER AVE. • CLEVELAND 14, OHIO

CIRCLE 39 ON READER-SERVICE CARD

Fast Response
conax®
BARE WIRE THERMOCOUPLE GLANDS



provide the only simple positive method for sealing two or more bare wires at pressures from full vacuum to 20,000 psi.

Low mass, unshielded, bare wire thermocouples give almost instantaneous response to temperature changes assuring greater accuracy of measurement and control.

- **Temperature range— —300°F to +1850°F**
- **All stainless steel construction**
- **Complete range of sizes**
- **Available from stock**

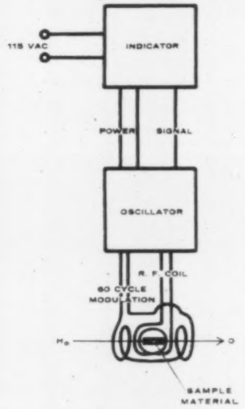
WRITE FOR CONAX DATA BOOK SHOWING COMPLETE LINE OF THERMOCOUPLE ASSEMBLIES AND PRESSURE SEALING GLANDS.

conax corporation
2316 Walden Ave., Buffalo 21, N. Y.

CIRCLE 40 ON READER-SERVICE CARD

ICS BRIEFS

NMR Precision Gaussmeter



The Model G-501 Precision Gaussmeter consists of three interconnected parts, (1) Probe, (2) Oscillator, (3) Indicator. The probe, containing the sample material, is positioned in the magnetic field of the magnet under surveillance. The sample material absorbs RF energy at a particular resonant frequency determined by the magnetic field strength, and the known physical constants of the sample material. RF energy is applied to the sample volume by a radio-frequency coil surrounding the sample. This coil forms part of the tuned circuit of the oscillator and provides the means for an indication of circuit loss in the coil caused by the absorption of RF energy by the nuclei of the sample when resonance occurs. The indication of resonance is shown on the cathode ray tube built into the indicator panel . . . (*From new 4-page brochure, Harvey-Wells Electronics, R & D Div.,* 5168 *Washington St., West Roxbury* 32, *Mass.*)

FOR THIS LITERATURE CIRCLE 178 ON READER-SERVICE CARD

Thermocouple Temperature Millivolt Tables

Thermocouple temperature-emf relationships based on Instrument Society of America and National Bureau of Standards tables (with exception of Plat. 30% Rh., Plat. 6% Rh.)

Abbreviations Used In Tables	ISA Symbol	Conductors Polarity Positive (+)	Negative (−)	Conversion Factor to 0°C Reference Junction †
I/C J	J	Iron	Constantan	+1.28 Millivolts
I/C Y	Y	Iron	Constantan	+1.32 Millivolts
C/A K	K	Chromel	Alumel	+1.00 Millivolts
C/C T	T	Copper	Constantan	+0.99 Millivolts
CR/C E	E*	Chromel	Constantan	+1.50 Millivolts
P10 S	S	Plat. 10% RH	Platinum	+0.143 Millivolts
P13 R	R	Plat. 13% RH	Platinum	+0.142 Millivolts
P30	P30*	Plat. 30% RH	Plat. 6% RH	+0.007 Millivolts

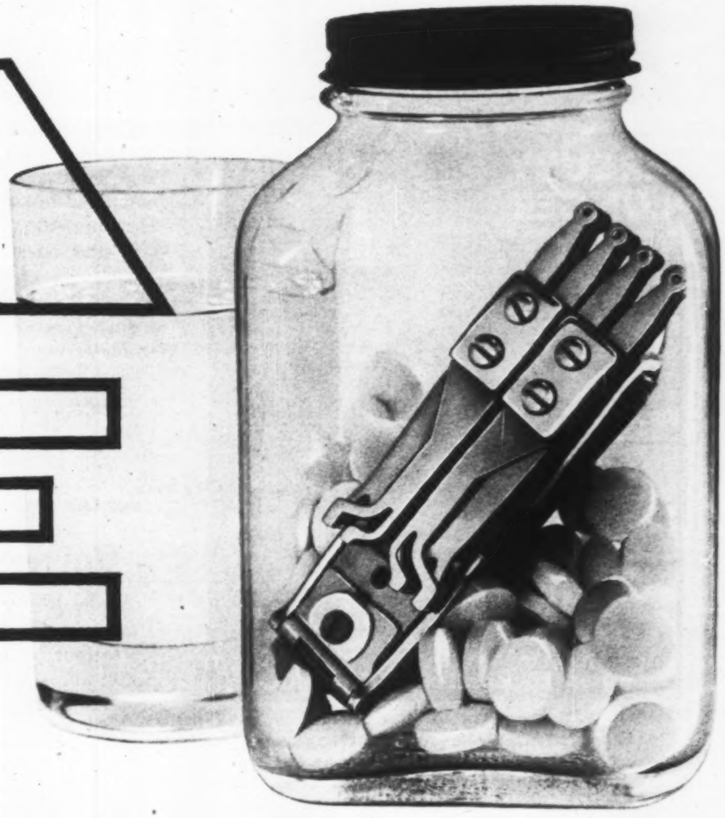
*Thermo Electric Symbol

† Conversion Factors to 32°F Reference Junction on reverse side

(*From new 4-page Table, Thermo Electric Co., Saddle Brook, N. J.*)

FOR THIS LITERATURE CIRCLE 179 ON READER-SERVICE CARD

AE



FOR THE ENGINEER

who can't sleep nights

If you're losing sleep over a sticky problem in automatic control, AE can help—because AE has a reputation for making things *work* automatically.

It's not surprising, considering our unique experience in the design of circuits and components for automatic telephone exchanges.

What's more, AE relays and stepping switches are unique in their own right—because they're built to have substantially zero variation in operating characteristics *for life.*

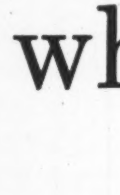
As an example: the AE Class B Relay, illustrated, provides hundreds of millions of operations with unfailing contact reliability, and seldom needs maintenance. For this reason, it is probably the most inexpensive relay you can use where infallibility is an essential.

AE relays and stepping switches are custom-made to *your* specifications—and are also available wired and assembled into complete control units. And we're always glad to suggest specialized circuits that may cut your end costs.

Want more information? Just write the Director, Control Equipment Sales, Automatic Electric, Northlake, Illinois.

Also yours for the asking: Circular 1702-E, *Relays for Industry*, and a new 32-page booklet on *Basic Circuits.*

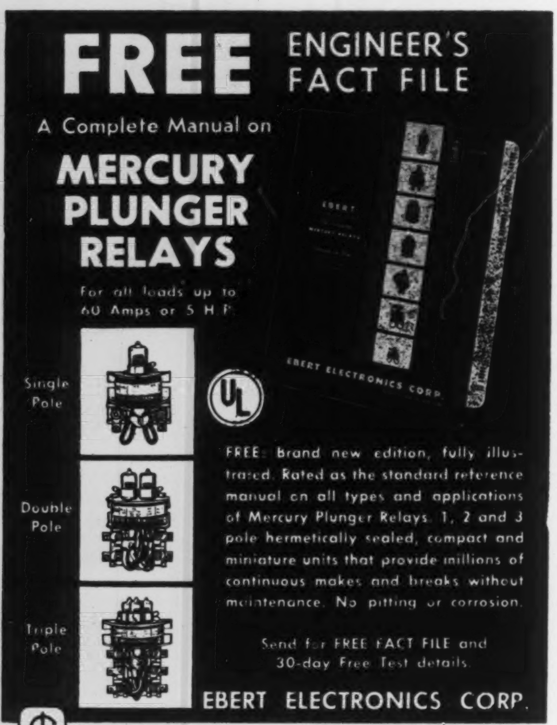
AE
CAN
DO



AUTOMATIC ELECTRIC

Subsidiary of
GENERAL TELEPHONE & ELECTRONICS

CIRCLE 41 ON READER-SERVICE CARD



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A Complete Manual on

MERCURY PLUNGER RELAYS

For all loads up to 60 Amps or 5 H P

Single Pole

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FREE: Brand new edition, fully illustrated. Rated as the standard reference manual on all types and applications of Mercury Plunger Relays. 1, 2 and 3 pole hermetically sealed, compact and miniature units that provide millions of continuous makes and breaks without maintenance. No pitting or corrosion.

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CANADA: Philips Electronics Industries Ltd., Toronto 17
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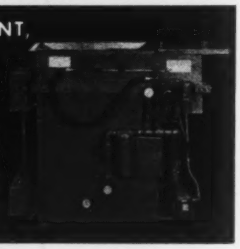
CIRCLE 42 ON READER-SERVICE CARD

For absolute cleanliness, low cost CIRCO ultrasonic degreasers and washers

CORROSION RESISTANT, STAINLESS CLAD CONSTRUCTION from $1595.00

(729 cu. in. cleaning area)



In case after case, where **absolute** product cleanliness is critical, CIRCO does the job...does it faster...does it cheaper. Choose from standard models to huge custom-designed conveyerized systems, **or** convert your present cleaning equipment merely by adding CIRCO ultrasonic transducers and controls. And, where conventional cleaning is sufficient, CIRCO offers a complete line of degreasing and washing units and degreasing solvents.

CIRCO *Equipment Company*
Specialists in Ultrasonic Energy
51 Terminal Ave., Clark, New Jersey • FUlton 8-8600

CIRCLE 43 ON READER-SERVICE CARD

Logic Switches

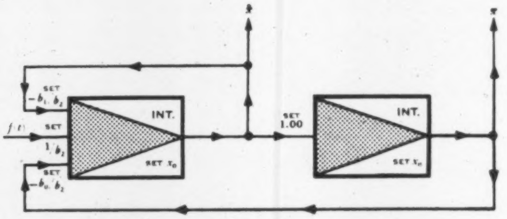
Tally Logic Switches are basically electro-mechanical power amplifiers of pulsed bi-stability with delayed configurations. Each switch includes an extensive complement of switching elements, providing massive logic combinations. Three basic elements are combined in each switch—a delay element, a bi-stable element, and a number of AND gates associated either with the assert or negative side of the bi-stable element . . .

One of the two logic states available in Tally Switches is always present in complete mechanically stable form. That is, power may be removed from the system without change in its logic state. This permanent memory feature is especially useful in pulse delay logic . . . (*From new 8-page Form TRC-LS-2, Tally Register Corp.,* 5300 *14th Ave., N. W., Seattle* 7, *Wash.*)

FOR THIS LITERATURE CIRCLE 180 ON READER-SERVICE CARD

Universal Linear Operator

Model K5-U Universal Linear Operator is an Electronic Analog Computing Component which accepts up to four input voltages, applies to each a weighting factor adjustable in increments of 0.01 from —11.10 to +11.10, and then obtains the sum in a choice of the following forms: (1) Multiplied by a constant adjustable from 1 to 1000 in power of 10, or by zero; and then added to an index value adjustable from —50.0 to +50.0 volts in steps of 0.1 volt. (2) Integrated, starting with an initial value adjustable from —50.0 to +50.0 volts in steps of 0.1 volt. The integrating speed is adjustable from 1.00 to 1000 radians per second in powers of 10. All these values are set by means of high accuracy decade switches on the front panel. The decade switch settings are direct reading; no calibration voltages need be measured . . . (*From new 4-page Bulletin K5-U, George A. Philbrick Researches, Inc.,* 285 *Columbus Ave., Boston* 16, *Mass.*)



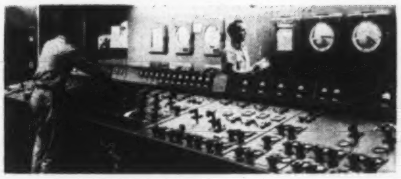
FOR THIS LITERATURE CIRCLE 181 ON READER-SERVICE CARD

ONE HUNDRED ELECTRONIC CIRCUITS
Volume I
Milton H. Aronson
Charles F. Kezer

COVERS

Power Supply Circuits	Test Instrument Circuits
Amplifier Circuits	Phase Shifters
Oscillator Circuits	Alarms
Pulse Circuits	Controllers

$2.00 postpaid



HAGAN NEWSLETTER—MARCH

Behind the panel

HOW TO CONTROL 42 SOAKING PITS FROM A 50-FOOT CONTROL HOUSE

A major steel producer engaged in an expansion program projected the building of 42 new soaking pits, arranged in 14 rows of 3 pits each, but the space available for a centralized control house was only 50 feet long. This problem was presented to Hagan, along with certain considerations that had to be observed. These were--the panel must provide high visibility of pit temperatures, heaters wanted to be able to see the entire trend of the heat on recorder charts, metallurgists wanted daily access to individual pit temperature and fuel flow records, the instrument department wanted chart changing held to a minimum. Hagan's solution satisfied these seemingly irreconcilable requirements. Here is how it was done: A new Hagan instrument that includes a highly readable pit temperature indicator, plus a 24-hour chart which records pit temperature and fuel flow, satisfied both heater and metallurgist, without the necessity of withdrawing the instrument chassis from its protective case. All row variables--flue pressure, air pressure, combustion air temperature and recuperator temperature--are recorded on miniature 30-day strip charts. The panel width for one row is exactly 42 inches so that the total width for the 42 pits will be 49 feet, well within the specifications. (Details on request. Ask for Item M-1)

HAGAN SYSTEM KEEPS AUTO TIRES AT pH 6.8

At one stage in the curing of tire rubber, it flows through huge tuber tanks where water must be maintained exactly at a pH of 6.8. This part of the process insures the elimination of hairline cracks in tires after weathering. The Hagan system constantly measures water flow into the tanks and, at the same time, the pH of the water. These two signals are combined to adjust the stroke of an acid feed pump which injects an accurately measured amount of acid into the main water system. The two measurements are made so accurately that the pH of the water has been maintained at exactly 6.8 despite widely varying flows. (Details on request. Ask for Item M-2)

BAKING OVEN FOR MISSILE WINGS CONTROLLED BY HAGAN

Missile wings made of honeycomb aluminum covered with a plastic resin must be cured in an oven that not only bonds the plastic to the aluminum core, but also assures a smooth and hard surface resistant to air erosion. The control system programmer establishes the desired temperature and duration of the curing process. Temperatures are slowly elevated and then reduced over a 12 to 24 hour period. A Hagan GT thermostat senses the temperature in the oven and sends a signal to a Hagan Ratio Totalizer. Any error between transmitted temperature and set point brings about the regulation of a blending damper controlling the amount of ambient air blended with electrically heated air. Engineers like the system because of its simplicity and the ease with which programs can be changed to meet new conditions. After two years of operation, the system has proved extremely accurate, and maintenance has been only routine. (Details on request. Ask for Item M-3)

BASIC OXYGEN STEEL PROCESS CONVEYORS GO PNEUMATIC

Among the steel companies who are making use of the new basic oxygen process, one has come to the conclusion that the best way to convey burnt lime and limestone to the vessel is pneumatically. And, to make sure that the system works accurately and with the least possible maintenance, the control system should also be pneumatic. On this particular system, Hagan controls the flow of material from the track hopper to the holding bin to the batch hopper. At each point, interlocking controls assure that the flow of material will be uninterrupted and will arrive at the vessel in the exact quantities demanded by the operator. In operation for over two years, the system has proved efficient and dependable and has required only routine maintenance. (Details on request. Ask for Item M-4)

HAGAN CHEMICALS & CONTROLS, INC., Hagan Building, Room 711, Pittsburgh 30, Pa.

HAGAN DIVISIONS: CALGON CO. – HALL LABORATORIES – BRUNER CORP.

FOR INFORMATION ON M-1 CIRCLE 44, M-2 CIRCLE 45, M-3 CIRCLE 46, M-4 CIRCLE 47

Dillon Force Gauge

MEASURES TENSILE OR COMPRESSION LOADS

- Accurate to within 1% of full scale capacity.
- Jewelled dial indicator repeats perfectly.
- Shockless mechanism for rough jobs.
- Red maximum pointer registers peak loads.
- Optional switch controls mechanisms.
- Accommodates wide variety of attachments.
- Available as combination push-pull model.
- Extremely compact. Fits into "tight" spaces.
- Flexes millions of cycles without damage.

WRITE FOR FREE ILLUSTRATED CATALOG AND PRICE LIST

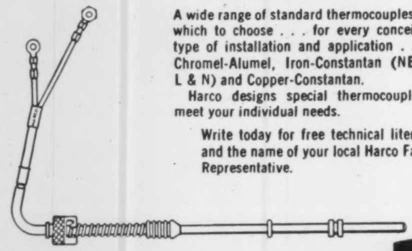
12 different capacities from as low as 0-10 lbs. up to as high as 0-50,000 lbs.

W. C. Dillon & CO., INC.
14584 Keswick St.,
Van Nuys 13, Calif.
P-56

CIRCLE 48 ON READER-SERVICE CARD

thermocouples

Harco has thermocouples to meet all your temperature sensing requirements. The result of proven design, careful control and selection of materials, skillful workmanship, and continuous inspection during manufacture, these instruments can be counted on for an exceptionally high degree of accuracy and long, dependable service.



A wide range of standard thermocouples from which to choose . . . for every conceivable type of installation and application . . . in Chromel-Alumel, Iron-Constantan (NBS or L & N) and Copper-Constantan.

Harco designs special thermocouples to meet your individual needs.

Write today for free technical literature and the name of your local Harco Factory Representative.

HARCO

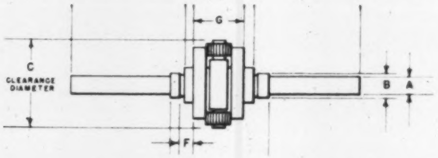
HARCO LABORATORIES, INC.
79 Olive Street, New Haven, Conn.

CIRCLE 49 ON READER-SERVICE CARD

ICS BRIEFS

Precision Differentials

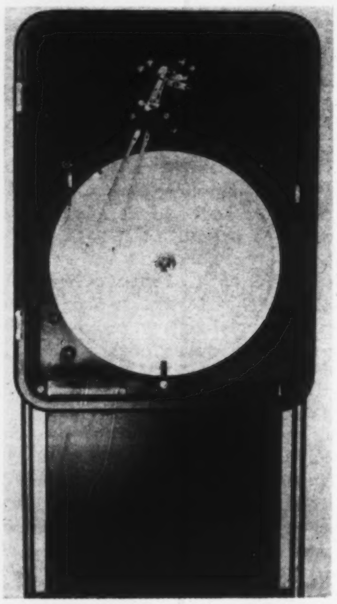
Advantages of Solid Shaft Differentials SI 110 are: (1) made of precision ground, corrosive resistant materials; (2) small "package" size; (3) they are very inexpensive; (4) suitable for commercial as well as military instruments; (5) end gears are easily detached, by loosening 3 screws; (6) they meet applicable military specifications . . . (*From new 4-page bulletin, Superite Instrument Corp., 7 Mayflower Pl., Floral Park, L. I., N. Y.*)



FOR THIS LITERATURE CIRCLE 182 ON READER-SERVICE CARD

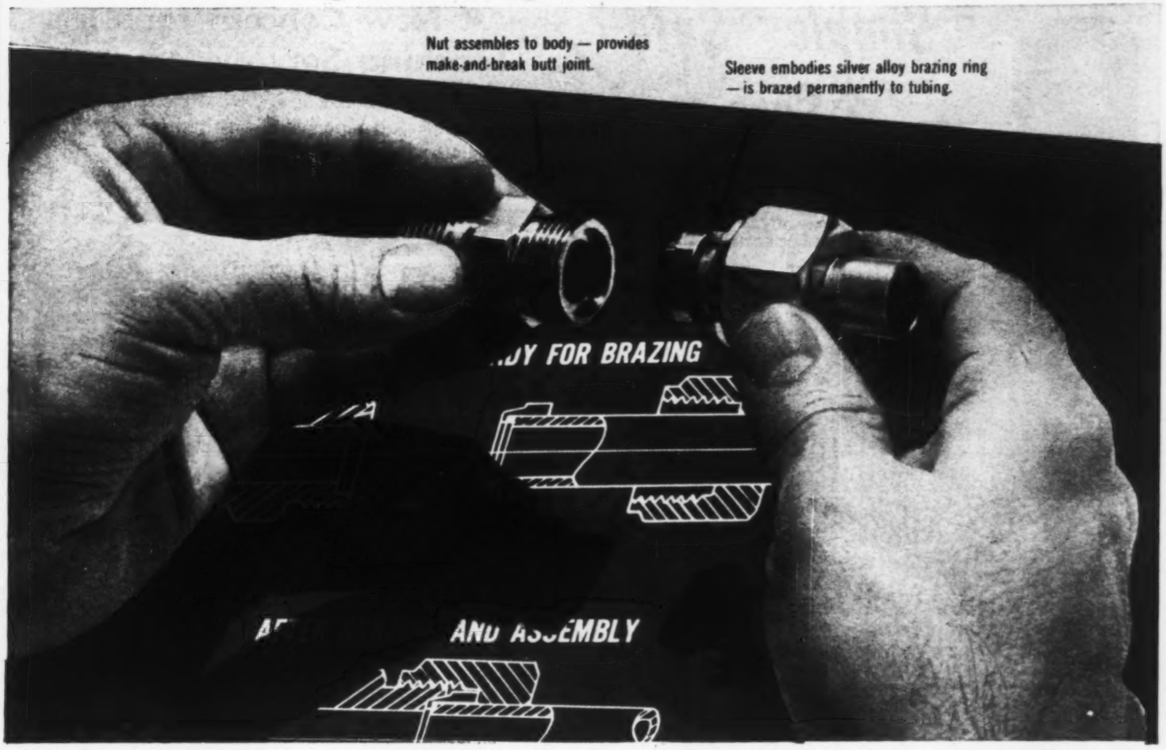
Automatic Chart Changer

New chart changing principle combines with universal type chart drive, either standard spring wind, jeweled or gas driven never wind . . . Loads up to 31 charts at a time. Each revolution of the chart actuates a release mechanism that drops one chart into the Dial-O-Graph magazine, for collection on a later date . . . One chart dialed off every chart revolution, regardless of the time necessary for that revolution. The top chart when completely recorded is dialed off and dropped into the chart receptacle attached below the meter case, the second chart is instantly in place for a new recording . . . (*From new 6-page pocket-size pamphlet and 3-page bulletin, Mullins Mfg. Co.,* 3311 *W. Davis St., Dallas* 11, *Texas.*



FOR THIS LITERATURE CIRCLE 183 ON READER-SERVICE CARD

IMPERIAL
Engineering and Data File


Nut assembles to body — provides make-and-break butt joint.
Sleeve embodies silver alloy brazing ring — is brazed permanently to tubing.
..DY FOR BRAZING
AF... AND ASSEMBLY

NEW BRAZE-SEAL FITTING

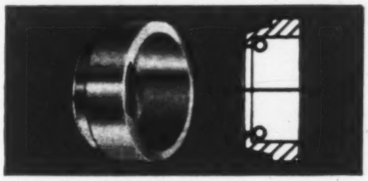
WITHSTANDS SUPER-PRESSURES, HIGH TEMPERATURES ... RETAINS MAKE-AND-BREAK CONVENIENCE

Until Imperial Braze-Seal came along, engineers could not specify an economical make-and-break fitting for tubing circuits involving super-pressures and high temperatures. Applications like these called for welded connections. But now Braze-Seal offers high reliability, even under extreme pressures. (See chart below.)

MAXIMUM DESIGN PRESSURES (PSI) FOR BRAZE-SEAL FITTINGS

Tube O.D.	316 Stainless	Carbon Steel
3/8"	64,000	48,000
1/2"	62,400	46,800
9/16"	61,600	
5/8"	61,600	46,200
3/4"	60,000	45,000
7/8"	56,000	42,000
1"	52,000	39,000
1-1/4"	48,000	36,000
1-1/2"	44,000	33,000

Application of the following safety factor is recommended: 4 to 1, for sizes up to ¾" O.D.; 6 to 1, for sizes ⅞" to 1½" O.D.



This Braze-Seal Sleeve, containing a silver alloy brazing ring, is the key to the performance of the Braze-Seal Fitting. It assures a joint that will withstand these extreme pressures because it is permanently brazed to tubing. Yet the fitting provides the convenience of a make-and-break butt joint, as illustrated, and is extremely easy to assemble.

Reducing Sleeves Provide Versatility

Can be furnished to reduce any size Braze-Seal tube end to any specified tube size. Extremely convenient on tees, for example, where any size tubing can be connected to the same tee body.

Also, the same body may be used for making up flareless Hi-Seal fitting joints.

Imperial Braze-Seal Tube Fittings can be furnished in steel or stainless steel.

Check the outstanding features of Braze-Seal for yourself. Send for a sample fitting. See how Braze-Seal can help you solve the most difficult problems in super-pressure and high-temperature tube circuitry.

IT'S IN THE BOOK

Braze-Seal Fittings are covered in Imperial's new Hi-Seal Catalog — the most comprehensive coverage available on the subject of fittings, a hard-working handbook for engineers. Send for your copy today.

HI-SEAL
TUBE FITTINGS

THE IMPERIAL BRASS MANUFACTURING CO.
Dept. ICS-30, 6300 West Howard Street
Chicago 48, Illinois 8-60

CIRCLE 50 ON READER-SERVICE CARD

Low Cost
PURGE METERS
*Simple *Safe
*Sure

New Series C M acrylic plastic PURGE METERS have been developed for all purging applications requiring a positive flow indication and maximum reproducibility of small flow conditions. Drilled, reamed and polished, these precision engineered units provide the ideal method of inexpensively measuring small gas or liquid flows where high accuracy is not paramount. Etched scales permit direct, easy readings and advanced flow control valve offers improved convenient control. Solid, one piece construction insures trouble-free operation. From $5.00.

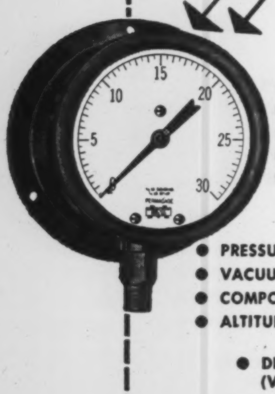
Send for
Bulletin 0100

C-MAR corporation
35 Euclid Avenue, Manasquan, N. J.
EXPORT DIVISION: Empire State Bldg., N. Y. 1, N. Y.

CIRCLE 51 ON READER-SERVICE CARD

MARSHALLTOWN

THE RIGHT GAUGE
FOR YOUR
SPECIFIC NEEDS



Available in a wide variety of general purpose and special purpose gauges in pressure ranges to meet your specifications in every particular.

- PRESSURE
- VACUUM
- COMPOUND
- ALTITUDE
- COMBINATION
- DIAPHRAGM
- HYDRAULIC
- AND SPECIAL PURPOSE GAUGES
- DIAL THERMOMETERS (Vapor Tension or Bi-Metal)

WRITE TODAY FOR COMPLETE INFORMATION

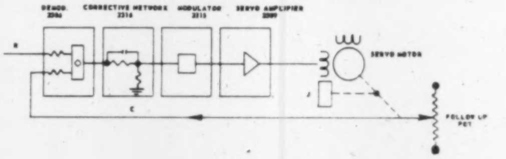
MARSHALLTOWN MFG. COMPANY
MARSHALLTOWN 3, IOWA

CIRCLE 52 ON READER-SERVICE CARD

ICS BRIEFS

A New Concept for Teaching Servosystems

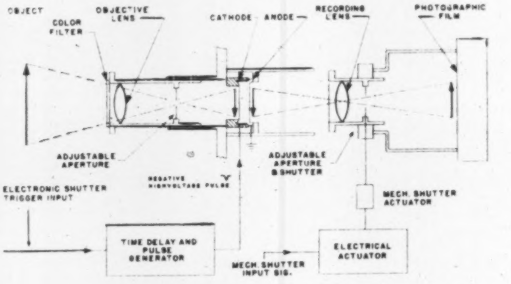
Servolab is a packaged assembly of electronic and electro-mechanical components constituting a highly versatile synthesis and analysis system. With it, the dynamic characteristics of control systems and feedback loops can be tested, demonstrated and displayed. The entire system, or any specific portion, can be literally put through its paces . . . Servolab modules enable the student to synthesize every kind of system . . . The following are just some of the types of systems which can be readily handled) by students: Deadzone, Coulomb striction, friction, Viscous friction, Backlash, Compliance, Torque constants, Inertia, Gear ratio effects, Transport . . . (*From new 8-page Report SR-3, Servo Corp. of America, 111 New South Rd., Hicksville, L. I., N. Y.*)


DEMOD.
CORRECTIVE NETWORK
MODULATOR
SERVO AMPLIFIER
R
SERVO MOTOR
C
FOLLOW UP POT

FOR THIS LITERATURE CIRCLE 184 ON READER-SERVICE CARD

Portable High-Speed Framing Camera

The Model 1 can take four separate pictures either in sequence or simultaneously. The time duration of each exposure is independently set by a convenient control. An external electrical signal will synchronize the exposure with any desired event. The time delay between the synchronizing input signal and the exposure is continuously adjustable from 1 to 1000 microseconds. Any exposure can be triggered from any previous exposure, giving a total delay time of 4,000 microseconds. The Model 1 uses special image converter type tube shutters developed by Abtronics . . . (*From new 2-page pamphlet "Electronic Camera," Abtronics, Inc., 64 South P St., Livermore, Calif.*)


OBJECT
COLOR FILTER
OBJECTIVE LENS
CATHODE
ANODE
RECORDING LENS
PHOTOGRAPHIC FILM
ADJUSTABLE APERTURE
NEGATIVE HIGHVOLTAGE PULSE
ADJUSTABLE APERTURE & SHUTTER
ELECTRONIC SHUTTER TRIGGER INPUT
MECH. SHUTTER ACTUATOR
TIME DELAY AND PULSE GENERATOR
MECH. SHUTTER INPUT SIG.
ELECTRICAL ACTUATOR

Functional diagram of one channel.

FOR THIS LITERATURE CIRCLE 185 ON READER-SERVICE CARD

Size for Size...
New ASCO Midget 3 Way
Solenoid Valve
provides

UNMATCHED FAST RETURN
UNMATCHED FAST RETURN
UNMATCHED FAST RETURN
UNMATCHED FAST RETURN

Of Cylinders and Diaphragms

INTEGRAL OVERSIZE ORIFICE SPEEDS EXHAUST CYCLE . . . ELIMINATES SEPARATE QUICK VENT VALVE.

New 3 way Bulletin 8317 with full ¼″ diameter exhaust orifice provides quick venting of pressure from cylinders and diaphragms . . . assures the fastest cylinder or diaphragm return of any valve its size. It takes the place of larger, more expensive valves . . . eliminates need for connecting a separate quick vent valve in the circuit to speed up the exhaust cycle.

This ASCO valve has only 2 moving parts, mounts in any position. Available in normally open, normally closed and universal construction . . . with general purpose, explosion proof or watertight solenoid enclosures in ¼″ pipe size . . . for pressures to 160 p.s.i. . . . for water to 100°F, air, gases and light hydraulic oil to 180°F.

The Bulletin 8317 Valve is available immediately from stock. **WRITE** for catalog literature and for the new ASCO Stock List & Selection Guide listing the world's largest stock of solenoid valves for immediate delivery.

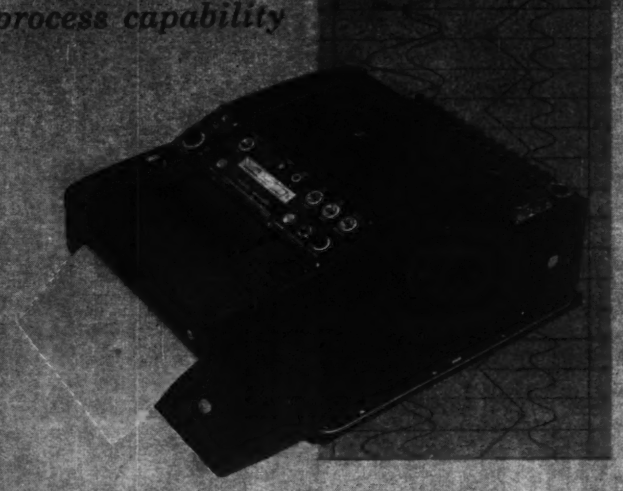
ASCO Valves

ASCO

Automatic Switch Co. 52-F HANOVER RD., FLORHAM PARK, N. J., FRONTIER 7-4600
AUTOMATIC TRANSFER SWITCHES • SOLENOID VALVES • ELECTROMAGNETIC CONTROL

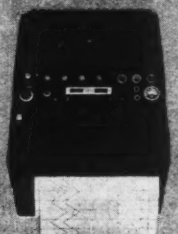
CIRCLE 53 ON READER-SERVICE CARD

A UNIVERSAL
RECORDING OSCILLOGRAPH
with 3-process capability



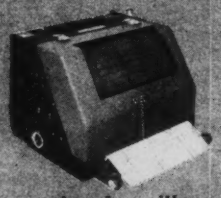
It's a print-out oscillograph... an automatic processing rapid-access oscillograph... a conventional oscillograph. It's a single engineering research tool with directly interchangeable magazines that precisely records up to 50 channels of static or dynamic data—simultaneously.

CEC's 5-119V Recording Oscillograph is designed with twin recording banks of individual magnet blocks, each with its own galvanometer light source. This lets the test engineer record low-speed data with low light intensity and high-speed data with high light intensity—simultaneously.



The 5-119V converts quickly to:

A print-out oscillograph with a high-actinic light source and a slot-exit magazine that clearly resolves writing speeds in excess of 50,000 ips... reproduces records on standard print-out papers without chemical processing.



An automatic processing rapid-access oscillograph that processes standard photographic papers... provides ready-to-read test results in 0.8 second after exposure at 25 inches per second.

A conventional oscillograph using 12-inch recording films or papers that are processed after the record run.

For complete details on the 5-119V and its accessories, call your nearest CEC sales and service office or write today for Bulletin CEC 1536-X13.

Electro-Mechanical Instrument Division CEC

CONSOLIDATED ELECTRODYNAMICS / pasadena, california

A SUBSIDIARY OF Bell & Howell • FINER PRODUCTS THROUGH IMAGINATION

ICS EVENTS

March 23-24
10th Annual Iron & Steel Conference, Pick-Roosevelt Hotel, Pittsburgh, Pa. For information write R. E. Blackwell, Box 1346, Pittsburgh 30, Penna.

March 24-25
1st Annual Symposium on Human Factors in Electronics, New York City. For information write R. R. Riesz, Chmn. Papers Procurement Comm., c/o Bell Telephone Labs, Murray Hill, N. J.

March 26
Fourth Annual Symposium on Recent Advances In Programming Methods, Ohio State University, Columbus, Ohio. For information write R. K. Kissinger, Nationwide Insurance Companies, 246 N. High St., Columbus, Ohio.

April 4-5
Solar Energy Symposium, sponsored by the University of Florida and the American Society of Mechanical Engineers, on campus of University of Florida. For information write John C. Reed, Mechanical Engineering Department, University of Florida, Gainesville, Fla.

April 4-6
Third Annual ISA Symposium on Progress and Trends in Chemical and Petroleum Instrumentation, Hotel Sheraton, Rochester, N. Y. For information write ISA, 313 6th Ave., Pittsburgh 22, Pa.

April 4-7
1960 Nuclear Congress, The Coliseum, New York City. For information write Nuclear Congress, 29W. 39th St., New York 18, N. Y.

April 4-8
Short Course in Strain Gage Techniques, Southwest Research Institute, San Antonio, Texas. For information write Dr. M. M. Lemcoe, SRI, P. O. Box 2296, San Antonio 6, Texas.

April 5
New Jersey Section of ISA Symposium on Computers In The Process Industry, Hotel Essex House, Newark, N. J. For more information write D. L. Lightstone, Robertshaw-Fulton Controls Co., 44 Grand Ave., Englewood, N. J.

April 6-8
Institute of Environmental Sciences National Meeting, Biltmore Hotel, Los Angeles. For information write Bruno Forscher, 16446 Bircher St., Granada Hills, Calif.

April 12-13
Ninth Annual Instrumentation Short Course, Los Angeles Harbor Junior College, Wilmington, Calif. For information write Maynard Strader, Union Oil Company of California, P. O. Box 758, Wilmington, Calif.

← CIRCLE 54 ON READER-SERVICE CARD

April 12-14
32nd Annual PIEA-PESA Conference and Exhibition, Municipal Auditorium and Muehlbach Hotel, Kansas City, Missouri. For information write Duane L. Thoe, Petroleum Industry Electrical Association, 2223 Dodge St., Omaha 2, Nebraska.

April 18-19
Third Annual Conference on Automatic Techniques, sponsored by the ASME, IRE and AIEE, Cleveland, Ohio. For information write J. H. McRainey, Room 530, 1213 W. 3rd St., Cleveland 13, Ohio.

April 19-21
10th Annual Symposium of Active Networks and Feedback Systems Engineering Societies Bldg., 33 W. 39th St., New York. Microwave Research Institute of Polytechnic Institute of Brooklyn. For information write Herbert J. Carlin, Microwave Research Institute, 55 Johnson St., Brooklyn 1, N. Y.

April 20-22
Twelfth Annual Southwestern I.R.E. Conference and National Medical Electronics Conference, The Shamrock Hilton Hotel, Houston, Texas. For information write SWIRECO, P. O. Box 22331, Houston 27, Texas.

April 20-22
Texas A & M Symposium on Instrumentation for the Process Industries, will be held on campus of Texas A & M. For information write N. E. Welch, Chemical Engineering Dept., Agricultural and Mechanical College of Texas, College Station, Texas

April 27-29
Sixth Annual Southern ISA Conference & Exhibit and First Pulp and Paper Division Symposium, Pensacola, Florida. For information write W. H. Matthews, P. O. Box 4426, Pensacola, Fla.

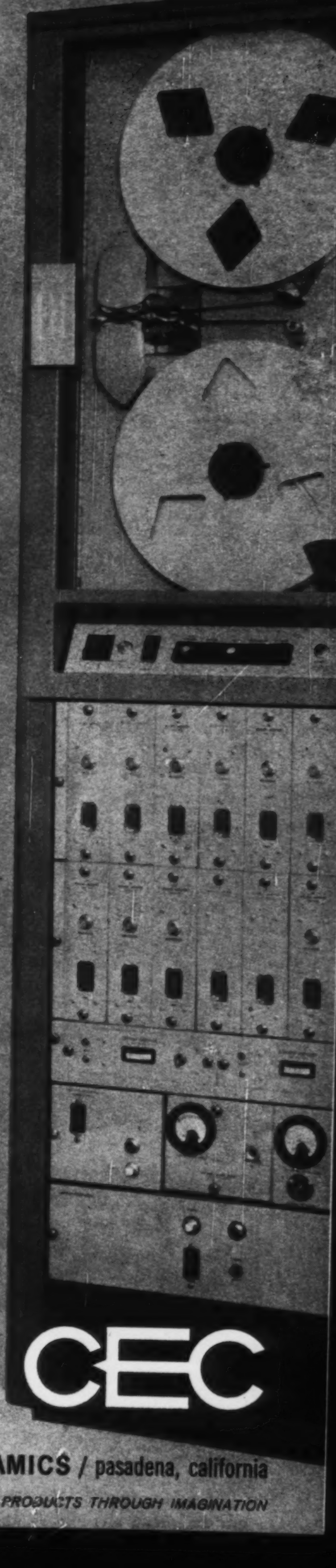
May 2-4
NAECON 12th Annual National Aeronautical Electronics Conference, Biltmore and Miami-Pick Hotels, Dayton, Ohio. For information write J. S. Horrigan, 5387 Maple Cliff Ct., Dayton 15, Ohio.

May 3-5
1960 Western Joint Computer Conference, Jack Tar Hotel, San Francisco, Calif. For information write H. M. Zeidler, Stanford Research Institute, Menlo Park, Calif.

May 9-12
Summer Instrument-Automation Conference & Exhibit of I.S.A., Civic Auditorium, San Francisco, Calif. For information write I.S.A., 313 6th Ave., Pittsburgh 22, Penna.

May 9-11
Annual PGMTT Symposium, sponsored by IRE Professional Group on Microwave Theory and Techniques, Hotel del Coronado, Coronado, Calif. For information write David B. Medved, CONVAIR, Division of General Dynamics, Mail Zone 6-172, Box 1950, San Diego 12, Calif.

June 16-18
Fifth Annual Symposium and Exhibit of American Scientific Glassblowers Society, Penn-Sheraton Hotel, Pittsburgh, Penna. For information write W. E. Barr, Gulf Research & Development Company, P. O. Box 2038, Pittsburgh 30, Penna.



CIRCLE 55 ON READER-SERVICE CARD ⟶

if you think this looks like CEC'S 5-752 . . .

YOU'RE
ONLY
HALF
RIGHT

The picture shown here is of a new, improved version of the famous 5-752 Recorder/Reproducer. We call it Model 5-752A, and it represents the culmination of years of engineering time and practical experience.

Never before such versatility.

Pick a mode . . . any mode: Analog, FM, PDM, CM, Digital. CEC's new 5-752A can handle any or all of them, with interchangeable Plug-In Amplifiers for five modes of recording or playback.

Monitoring versatility too.

The 5-752A features optional monitoring, either local or remote, of Signal Input/Output. True head-current monitoring also.

New features.

The cabinet is tougher than ever . . . it's all-steel, all-welded . . . all-rigid, too, for such rough environments as mobile or marine installations. And a new, metal-framed, transparent cover closes dust-tight on a gasket seal . . . gives protection where it counts, over the tape and heads. . .

Specially designed CEC Current Amplifiers slide right into place . . . boost reproduce amplifier signal output . . . give galvanometers, chart recorders, and other allied instrumentation the whole story, loud and clear.

For complete information on this most versatile of instrumentation recorders, call the CEC sales and service office nearest you, or write for Bulletin CEC 1576-X43.

CEC

DataTape Division

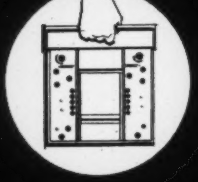
CONSOLIDATED ELECTRODYNAMICS / pasadena, california

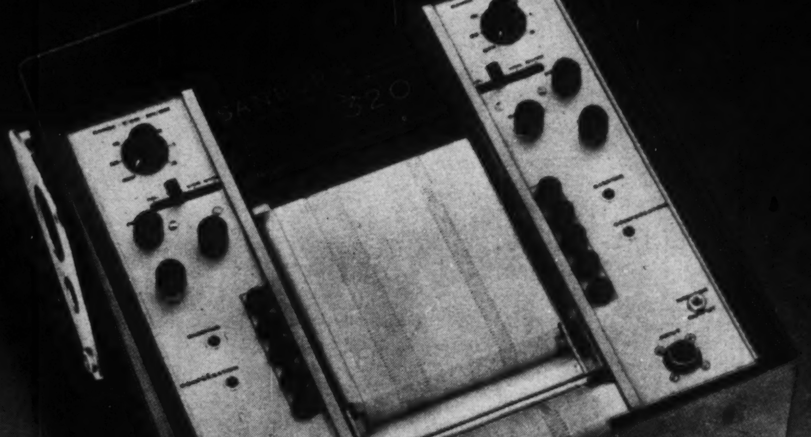
A SUBSIDIARY OF **Bell & Howell** • *FINER PRODUCTS THROUGH IMAGINATION*

NEW

MODEL 320

PORTABLE 2-CHANNEL..

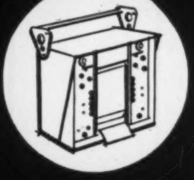


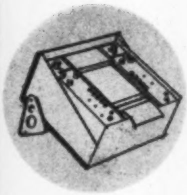


The new Sanborn Model 320 system — for general purpose DC recording in any part of the plant or on field assignments — combines rugged current-feedback amplifiers, 2-channel recorder assembly and dependable all-transistor circuitry in less than a cubic foot of space. And the many advantages of Sanborn multi-channel systems are incorporated in the new portable 320 — low impedance, enclosed galvanometers; clear, permanent traces made by heated styli; rectangular coordinate charts. Most components for each channel are mounted on one easily serviced card; others are readily accessible. The control panel permits easy access to the controls for each channel . . . provides for observation of 6 inches of the chart . . . and it can be set up for use vertically, horizontally or at a 20° angle using the adjustable stand/carrying handle.

Your nearest Sanborn Sales-Engineering Representative can provide you with complete data or write the main office in Waltham. Sales-Engineering Representatives are located in principal cities throughout the U. S., Canada and foreign countries.

DIRECT WRITING SYSTEM





- **up to 0.5 millivolt/mm sensitivity**
- **inputs floating and guarded for each channel**
- **rectangular coordinate charts full 50 mm wide**
- **only 12¾" square, 8¾" deep**
- **4 pushbutton chart speeds**
- **completely transistorized**

SPECIFICATIONS

electrical

Sensitivity Ranges	0.5, 1, 2, 5, 10, 20 mv/mm and v/cm
Input Impedance	½ megohm on mv/mm ranges and 1 megohm on v/cm ranges
Frequency Response	3 db down at 125 cps, 10 div peak-to-peak
Common Mode Voltage	± 500 volts maximum
Common Mode Rejection	140 db minimum DC
Linearity	maximum non-linearity – 0.2 mm with respect to chart center
Calibration	10 mv internal signal ± 1%
Limiting	approx. ± 115% of full scale
Rise Time	4 milliseconds with less than 4% overshoot

physical

Input Connectors	separate for each channel
Output Connectors	40 mv/mm sensitivity for connection of external monitoring scope to each channel
Dimensions	approx. 12¾" by 12¾" by 8¾"
Weight	approx. 55 lbs.

Controls
(for each recording channel)

Range Switch	6 positions and off
Smooth Gain Control	
Function Switch	4 positions – Zero, Cal, Use mv/mm Use v/cm
Position Control	
Stylus Heat Control	
Galvanometer Damping	(screwdriver adjusts.)
Galvanometer Compensation	

(for the entire system)

Power ON-OFF	
Speed Control	1, 5, 20, and 100 mm/sec
Marker-Off-Timer	

Data subject to change without notice.

See this new System at the I.R.E. Show—Booths 3601–03–05

SANBORN COMPANY
INDUSTRIAL DIVISION 175 Wyman Street, Waltham, Massachusetts

CIRCLE 56 ON READER-SERVICE CARD

Millions of Monitors ... for Hundreds of Applications

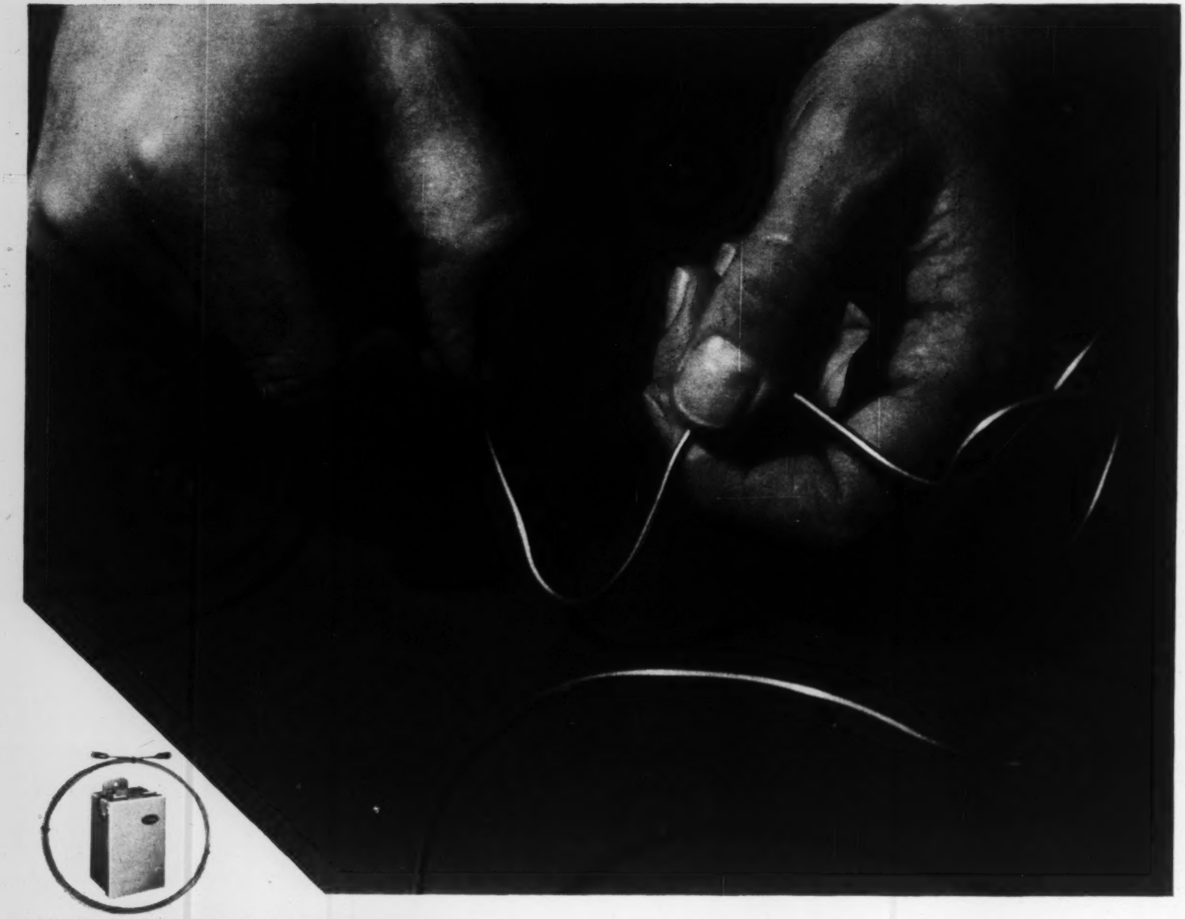
... The Fenwal Line Temperature Detector

There are millions of separate, individually distinct temperature "monitors" in a length of the Fenwal Line Temperature Detector's sensing tubing. It's packed with a thermally sensitive eutectic salt compound surrounding a center conductor. *Any point* on the tubing responds instantly and precisely to an undesirable temperature . . . electrically activates alarm and/or corrective control. This *discrete sensing* eliminates the errors inherent in systems based on averaging.

Fenwal Line Temperature Detectors have repeatedly proved their reliability in aircraft and missiles. They are equally applicable in industry: on bearings, in engine test cells, catalyst beds, electric generators, for transformer protection, and elsewhere.

Flexible sensing element mounts easily — forms continuous loop back to compact control unit. Several sections, each set for a different temperature, can be connected in series to operate independently. Rugged design provides constant, fast-acting protection . . . resets automatically.

If you have many points to monitor, chances are a *flexible* Fenwal Line Temperature Detector . . . formed to your exact configuration . . . would help. Talk the application over with a Fenwal Sales Engineer. Write Fenwal Incorporated, 363 Pleasant Street, Ashland, Massachusetts.



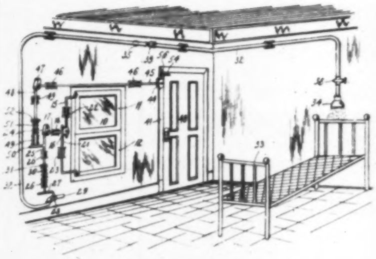
Line Temperature Detector

Another example of how **Fenwal** **CONTROLS TEMPERATURE . . . PRECISELY**

CIRCLE 57 ON READER-SERVICE CARD

ICS PANHANDLE PETE

Automatic Burglar Alarm

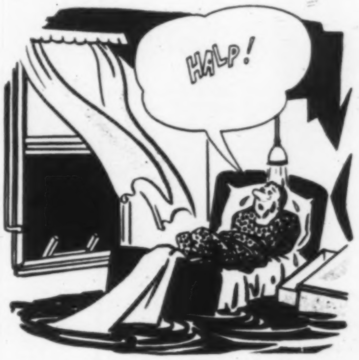


One of the objects of the present invention is to provide a burglar alarm which can be readily adapted to a door or window, in such a manner that the opening of the door or window will produce an alarm in the form of a water spray issuing from a spray nozzle, which is arranged above the bed occupied by the person to be awakened by the opening of a door or window in the house.

The operation of this device is as follows: To bring the parts of the alarm into their operative positions, first the cocks 38 and 39 are set to open a communication between the faucet 28 and the spray-nozzle 34. The racks 15 and 21 are attached by the wing nuts 14 and 20, respectively, to the upper and lower sashes of the window. The keeper 56 is then disengaged from the projection 55 upon the rack 43, whereby the device is ready for operation.

Arnold Zukor
Patent 1,046,533
December 10, 1912

If the burglar gets there first:



Tail-Operated Positioner

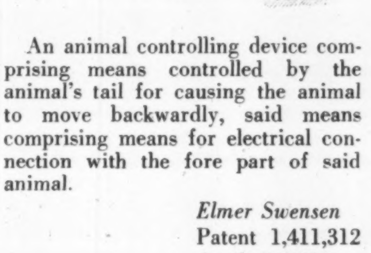
My invention relates to an electrical system adapted for use in cattle stalls.

It is especially desirable in stalls, and especially where a large number of animals are kept, to provide some means which will cause the animal in the stall to step backwardly at the time of evacuation to deposit the droppings of the animal in a gutter suitably located at the rear of the stall.

It is therefore one object of my invention to provide electrical means which subject the animal to an electrical shock at the time of evacuation.

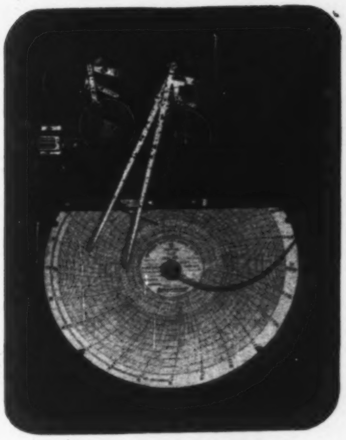
What I claim as new and desire to secure by Letters Patent is—

The combination with a stall and a gutter, of means controlled by movement of the animal's tail for causing the animal in the stall to move back toward the gutter.



An animal controlling device comprising means controlled by the animal's tail for causing the animal to move backwardly, said means comprising means for electrical connection with the fore part of said animal.

Elmer Swensen
Patent 1,411,312
April 4, 1922



AMERICAN® INTEGRATING ORIFICE METERS

American Integrating Orifice Meters provide more accurate measurement by the continuous multiplication of the square root of the measured differential by the square root of the absolute line pressure.

Single, double and duplex-integrating models available in a wide range of manometer types and working pressures. Dust-proof, die-cast aluminum cases... Gasclok and electric instrument chart drives. Also supplied with American Telecounter for remote readings.

Ask for Bulletin 401 for complete details.

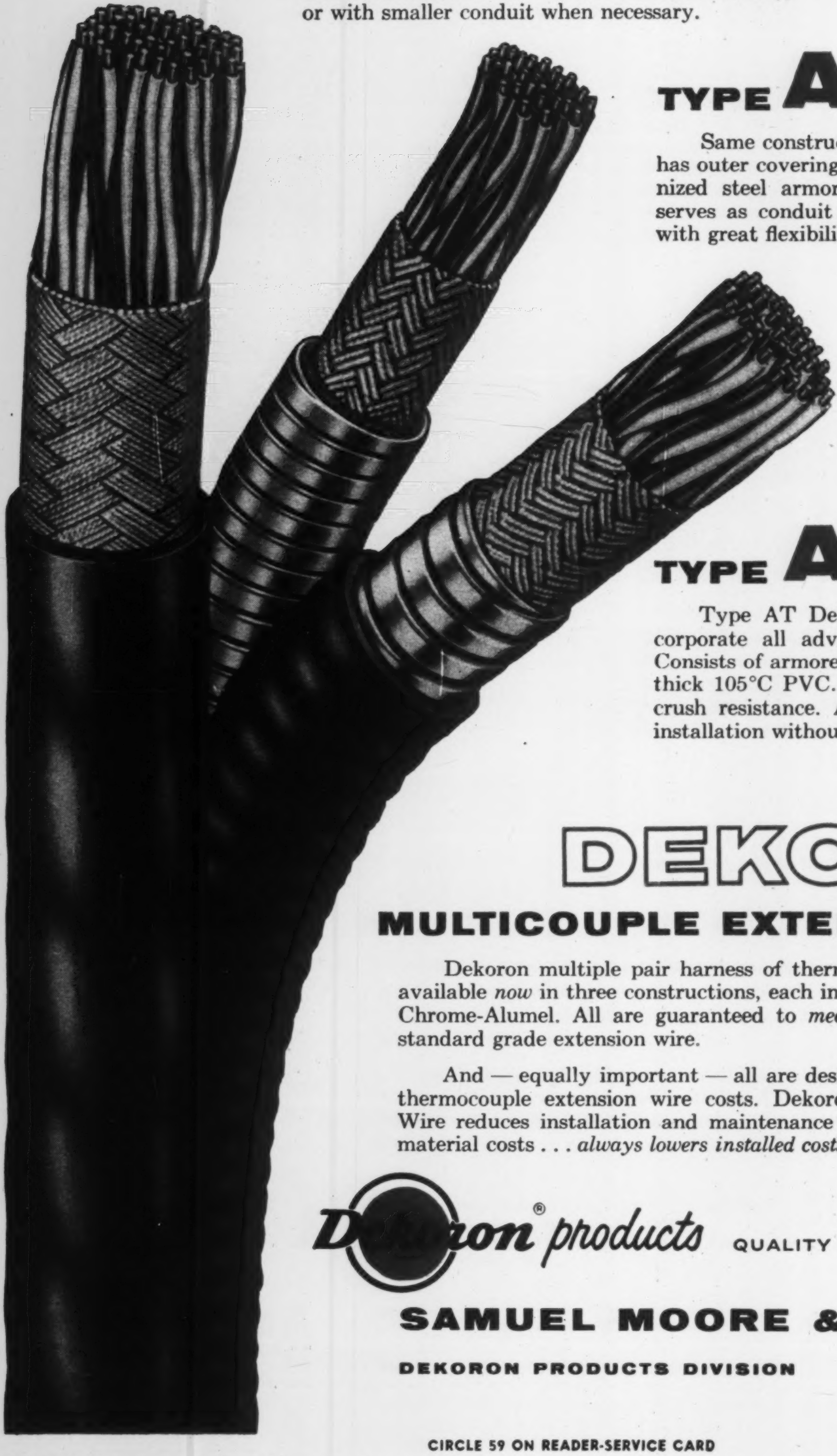
AMERICAN® METER COMPANY
INCORPORATED ESTABLISHED 1836
General Offices: Philadelphia 16, Pa.
Sales Offices in Principal Cities

CIRCLE 58 ON READER-SERVICE CARD

NEW NEW NEW NEW

TYPE T

The economy cable, Type T Dekoron Multicouple Cable consists of insulated, numbered and twisted wires covered with 90% closed No. 30 cotton braid and outer sheath of .050″ thick 105°C PVC. Moisture and chemically resistant; approved for direct burial. Can be installed without conduit, or with smaller conduit when necessary.



TYPE A

Same construction as Type T, above, except has outer covering of modified square lock galvanized steel armor overall which shields cable, serves as conduit and provides crush resistance with great flexibility.

TYPE AT

Type AT Dekoron Multicouple Cables incorporate all advantages of Types A and T. Consists of armored Type A sheathed with .050″ thick 105°C PVC. Moisture, chemical, and high crush resistance. Approved for direct burial or installation without conduit in open racks.

DEKORON®

MULTICOUPLE EXTENSION WIRE

Dekoron multiple pair harness of thermocouple extension wire is available *now* in three constructions, each in either Iron-Constantan or Chrome-Alumel. All are guaranteed to *meet or exceed ISA specs* for standard grade extension wire.

And — equally important — all are designed to drastically reduce thermocouple extension wire costs. Dekoron Multicouple Extension Wire reduces installation and maintenance time . . . often cuts initial material costs . . . *always lowers installed costs.*

A-114A

Dekoron® products QUALITY • RESEARCH • SERVICE

SAMUEL MOORE & COMPANY

DEKORON PRODUCTS DIVISION • MANTUA, OHIO

CIRCLE 59 ON READER-SERVICE CARD

The sales managers of three leading analog-computer manufacturers answered a recent inquiry on size of analog computer market as follows:

	A	B	C
Installed Value (purchase price) of general-purpose EDA's (simulators) at end of 1958	$30 million	$80 million	$100-$150 million
Annual current rate of sales	$10-$14.5 million	$14 million	$25 million
1957 Sales	$ 8 million	$14 million	$20 million
1958 Sales	$10 million	$12 million	$25 million
1959 Sales (predicted)	$12 million	$14 million	$35 million
1960 Sales (predicted)	$15 million	$16.5 million	$50 million

Electric Production Resources Agency, BDSA, reports that 11,071,000 relays were shipped in first six months of 1959, worth $79,365,000. Both figures are 45% above same-period 1958 figures.

Industrial ball valve sales are skyrocketing, reports B. Moss of Hydromatics, Inc., being $5 million in 1959, and expected to reach $25 million in 1960, compared to $1 million in 1958. Military ball-valve sales were also $5 million in 1959, expected to be $25 million 1960.

School shops (industrial arts, wood, metal, etc.) will purchase $315 million worth of equipment in 1959, says W. E. MacLachlan of Rockwell, Delta Tools.

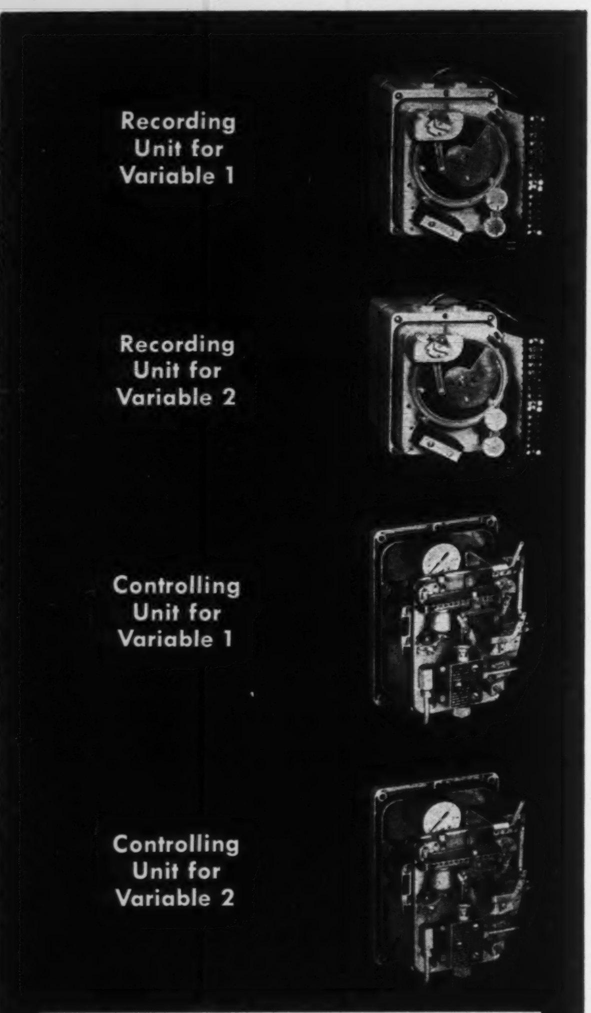
Gas industry sales exceeded $5 billion in 1959, says Gas Age; 1350 distribution companies and 100 transmission companies now serve 32.6 million customers; 205 underground storage pools have 2.7 trillion CF capacity; pipeline network comprises 595,600 miles.

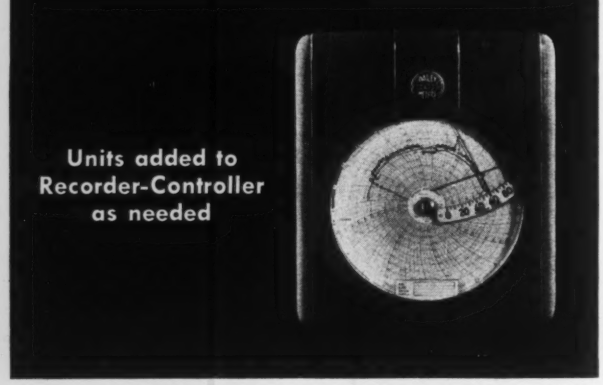
Electronic test, recording and measuring instrument market is estimated by F. Andrews of A. D. Little as follows (millions of dollars):

	1959	1960
Oscilloscopes	$10	$11
Oscillographs	15	16
Volt-ohmmeters	9	9
R,C,L measuring equipment	3	4
Analyzers for engine testing	25	25
Tube testers	6	5
Microwave test equipment	10	15
Signal generators	15	15
Transmitter test equipment	3	3
R-f measuring equipment	7	8
Indicating Instruments	25	27
Recording Instruments	30	30
Ultrasonic	4	5
Other test equipment	88	102
Total	$250	$275

Oscilloscope market is reported as $25 million in 1954, $50 million in 1960, and will be $75 million in 1962, says A. B. DuMont Labs.

Steady growth of between 15-20% will raise annual volume of the electronic test instrument industry to at least $350 million in 1960, says Albert F. Craig, Technical Information Corp., Power supply market should increase from $60 million in 1959 to at least $70 million in 1960.


Recording Unit for Variable 1
Recording Unit for Variable 2
Controlling Unit for Variable 1
Controlling Unit for Variable 2


Units added to Recorder-Controller as needed

Bailey Recorder is key to "step-by-step" automation

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ICS BOOKS

Materials & Techniques for Electron Tubes by Walter H. Kohl [c1960] Reinhold Publishing Corp., 430 Park Ave., New York 22, N. Y., 637 p., 9", clothbound $16.50. A completely revised edition of "Materials Technology for Electron Tubes" by the same author, the book covers all the material components of electron tubes and the fabricating methods. Includes extensive tables of physical properties of these specific materials.

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Electrical Efficiency in Industrial Plants, by Edwin S. Lincoln [c1959] F. W. Dodge Corp., 119 W. 40th St., New York 18, N. Y., 235 p., 9", clothbound, $9.50. This practical guide to help identify and eliminate the sources of power loss, describes the methods of making surveys of power load, voltage, lighting, wiring, and electrical protection with a description of the instruments used.

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Thermodynamics by Franklin P. Durham [c1954, 1959] Prentice-Hall, Inc., Englewood Cliffs, N. J., second edition, 349 p., 8½", clothbound, $8.35. This book endeavors to speak to the undergraduate student on his level by developing the basic theory in terms of a minimum number of simple equations. The concept of entropy is introduced early in the book and integrated along with the treatment of irreversible processes. It also introduces the concept of stagnation conditions in steady flow processes and stresses the importance of their use. Mollier chart, psychrometric chart, and a pressure-enthalpy diagram for Neon-12 are attached.

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The Servo Engineer's Handbook published by Daystrom Transicoil Div. of Daystrom Inc., Worcester, Montgomery Cty., Penna., [c1959] 128 p., 8⅞", paperbound, $3.00. Book is specifically devoted to servo components (motors, rate generators, synchros, gear trains, servo amplifiers, etc.), but includes also chapters on servo system engineering and environmental testing.

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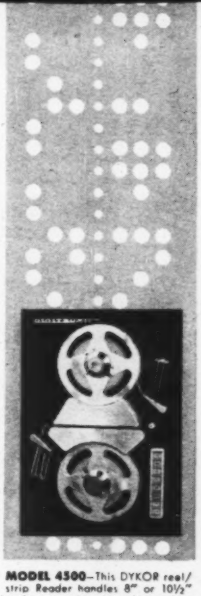

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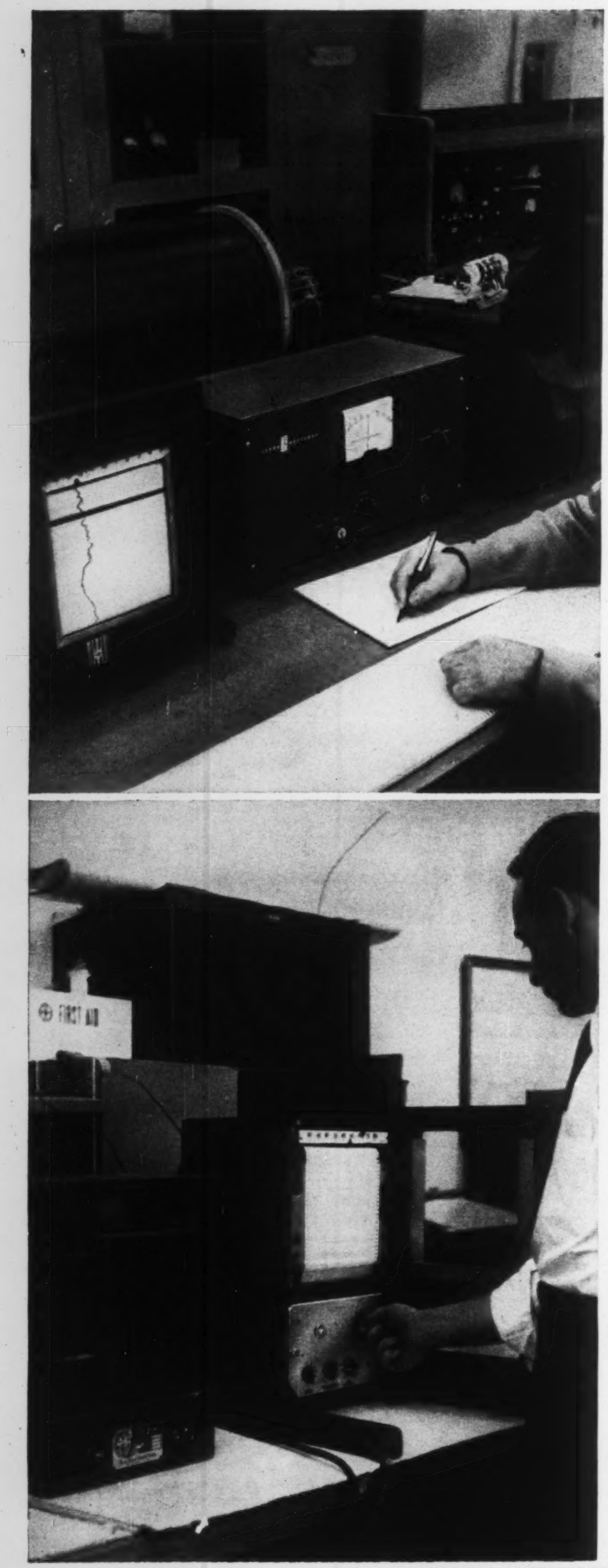

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THE ECONOMIC IMPORTANCE OF THE INSTRUMENTATION ENGINEERING SECTION

RICHARD RIMBACH

Mr. Chairman, Ladies and Gentlemen of the New Jersey Section, ISA:

I am happy to be here tonight performing a familiar function—a labor of love one might say—espousing the cause of the instrument man, the instrument department, and instrumentation.

For many years my voice was one of very few that were raised in support of these things. Would you like me to take just a moment to tell you what the field was like forty years ago?

If a man wanted to buy an instrument, he had no instrument catalogs or buyers' guides or magazines to go to. He hunted through general instrument catalogs until he found something that implied that the manufacturer made an instrument. The instrument manufacturer himself was surprised to find that somebody thought his instrument of value. He did *not* think of instrumentation as a separate field with its specialists; he thought of it as a part of other fields—process instrumentation as a part of the chemical field, electrical instrumentation as a part of the field of electrical engineering, and so on.

When I started the first trade journal in this field, more than 32 years ago, I was told by most instrument manufacturers that the field could never support a trade journal.

At that time I also had a discussion with one of the large publishing houses to obtain permission for an associate to become a part of our organization because he had sold his interests to the large publisher, and it was necessary for him to obtain a release. The permission was granted for two reasons—one was that the field of measurement and control would never amount to anything and the second reason was that this publisher would never put a publication into the field. But they are in the field today!

An here you are, wondering where you are, what the field is really like, and particularly, where you are going.

The key to many of our problems is that the field is basically *horizontal*, yet it has many *vertical* segments.

For example, every engineer and scientist should know the fundamentals of measurement, if not control, yet specialties exist in all phases of instrumentation—ultrasonics, analytical techniques, standards and calibration, stress analysis, digital computers, simulation, to name but a few.

It is this complexity and diversity of both product and technique that has made the Instrument Department essential for any large organization that performs significant amounts of either research, development, or production.

It can be safely said that today it is a rare industrial process or research project that is not drawing on many types of instrumentation—electrical, electronic, pneumatic, hydraulic, mechanical, optical, etc. —to monitor, to measure, and to control its operations. Although many managements are to be found that still believe its engineers should also be instrument men (and it is true that every engineer should know something of instrumentation), most managements discovered long ago that it is more efficient to have a central instrument facility that offered the following types of services:

1. **Instrument selection and modification to the task at hand**
2. **Instrument installation and maintenance**
3. **Instrument calibration and repair**
4. **Instrument advice and consultation to both operating and management personnel**
5. **Instrument use advice—including a training program for proper use of the instrument by operating personnel.**

Remember that we are using the word "instrument" in its broadest sense—anything that the process or plant worker needs to measure, monitor and control his operations or to meet his measurement and control needs. This is repeated because there is an ART to instrumentation that comes only with experience; the feel of this field that encompasses so many, if not all, the areas of modern physics and chemistry.

Thus the first point that can be made strongly is that the Instrument Engineering Section should exist as a separate entity—not only in the plant but also in the laboratory.

The techniques and equipments that are now available are so vast in number that no management should

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Address by Richard Rimbach, Publisher of INSTRUMENTS & CONTROL SYSTEMS, to New Jersey Section, ISA, Oct. 6, 1959 rely on its average engineers to provide the instrument services it needs. The proof here is that most organizations already have seen this obvious point. Only where personality and political conflicts between departments exist do we find the old-fashioned procedure of permitting every department to perform its own instrumentation without any direction from a central source.

Here we make another important point—the instrument department must always work closely with many other departments in the plant and laboratory, often in a consulting capacity. The degree to which this partnership with operating and research personnel is effected is a measure of the degree of success of the instrument department; we can make a good case for saying that the degree of responsibility that the instrument department can get will depend on the degree of responsibility it assumes.

This assumption of responsibility does not mean the common self-glorification via generalities, editorials, awards, titles, etc. Do not mistake the rituals and sham of organized groups with the accomplishments of the individual.

The Legitimate Functions of an Instrument Department

In the final analysis the responsibility one gets depends on how many of the legitimate basic functions of your instrument department are actually carried out by you. Let us review these functions again. They are worth repeating in slightly more detail. They are as follows:

A. Consulting-type measurement and control advisory service on any design, research or production project, including instrumentation assistance up to and including selection or construction of the apparatus required by the process or project.

B. Initial installation and calibration of the instrumentation.

C. Maintenance of a central instrument department with responsibility for repair and calibration of all instruments.

D. Modification and improvement of existing instruments and apparatus to meet the needs of the laboratory project or process.

E. Provide an education program for both professionals and technicians in proper use and reading of instruments, proper recording of data, fundamentals of physical measurements, and orientation in the basic fields involved in the laboratory or plant.

F. Survey the instrument literature to keep abreast of the many developments, and to inform appropriate scientists both of the literature and the developments.

G. Report to management on instrument needs of the plant or laboratory.

H. Consult with management on all matters related to instruments.

The degree of executive responsibility the instrument department will *finally achieve* will depend on the success you have in performing these *legitimate functions* of your department.

Note that the upper limit is very high indeed. If management were to be served in such a way that it relied on your judgement in all these matters, then there would be little question of status.

But let me point out that it is not enough to ask for status and plead for recognition while others are stepping into the functions that should belong to the instrument department. Here I am referring particularly to the new systems philosophy that is spreading like wildfire through our field.

Basically, a group of men from outside the field of instrumentation have entered the field by saying that they will lay out, design and tailor the instrumentation of the plant to the needs of the "system." They have succeeded in selling many managements on their ability to do this.

Where has the instrument department been while this is going on? Repairing pressure gages?

In this situation we see why, at the same time that our trade journals are full of stories about computer controlled plants, our instrument departments are pleading for status and recognition. What we may have here is the coming home to roost of the pigeon of *abdication* of responsibility. Since you didn't earn or assume the obligation for the control of the entire plant from its valves to its loggers and computers, others are doing it for you. Asking for status won't get it. You have to earn it.

Your position is still strong. There is and always will be an essential ART to process control and instrumentation, and you are the men who have that art. If you will look at the large responsibilities that you can legitimately assume in your systems, your future is bright.

Serious consideration should be given to the instrumentation involved just as early as it is given to the problems of underground lines, pipe bridges, plant streets, power lines, and other facilities. This is becoming more and more important with the general tendency toward centralized control of large operations and areas.

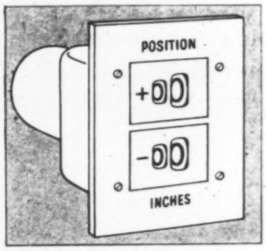
Therefore, plant managers will be well advised to:

1. Place the instrumentation specialist in the corporate structure across divisional lines.
2. Organize study teams composed of management, process and instrumentation engineers to consider the proper controls for processes at the design stages. In the design of future plants, the control should be considered first.
3. Make the instrument department responsible not only for the final indicating, recording and controlling equipment, but also for all other elements —from primary elements to control computer.
4. Arrange for the training of plant personnel in instrumentation under the direction of the instrument department.
5. Finally, see that the members of the instrument department have time to attend technical meetings, to meet with other instrument engineers and to keep abreast of latest developments.

Veeder-Root READOUT Bulletin

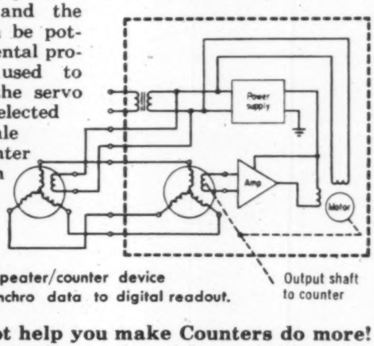
Readout Counter used in Tape Preparation for Machine Tool Control

A Veeder-Root Series 1538 Remote Data Readout Counter provides tape feed control for the motorized tape punching unit of the new Potter & Johnston Tape Control System. The tape punch is used to program machine functions on P & J Automatic Turret Lathes. The counter automatically controls the amount of tape feed required for each turret face involved, and stops the tape at preselected address points. When the correct address point is reached, a combination of holes representing the machine command is punched into the tape. Counter is automatically reset for each turret face.



Servo Repeaters Drive Counters to Indicate Lineal Motion*

One of the ways to take advantage of digital readout for indicating and recording information at remote points is through servo repeaters. Applications in aircraft, for altimeters, navigational displays and similar instrumentation, suggest many other opportunities to use counters for more positive indication and control. A typical "system" is shown here where a counter is used for indicating nuclear reactor rod position. The servo repeater and counter actually form one packaged unit, and the whole device can be potted for environmental protection. When used to drive counters, the servo gear ratio is best selected to provide full scale travel of the counter for one revolution of the control transformer shaft.



Typical servo repeater/counter device that converts synchro data to digital readout.

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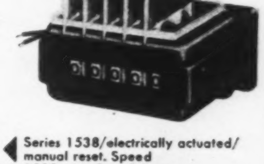
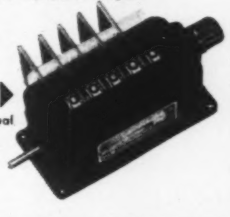
This is the basic series of Remote Data Readout Counters. Some are available for standard applications or design variations will be submitted based on requirements. They function basically as analog to digital converters.

Series 1538/electrical reset/electrically actuated. Speed 1000 cpm, 3 or 5 figure



Series 1538/electrically actuated/manual reset. Speed 1000 cpm, 3 or 5 figure



Series 1606/mechanically actuated manual reset standard; bi-directional (non-reset) available. Speed 5000 cpm, up to 5 figures

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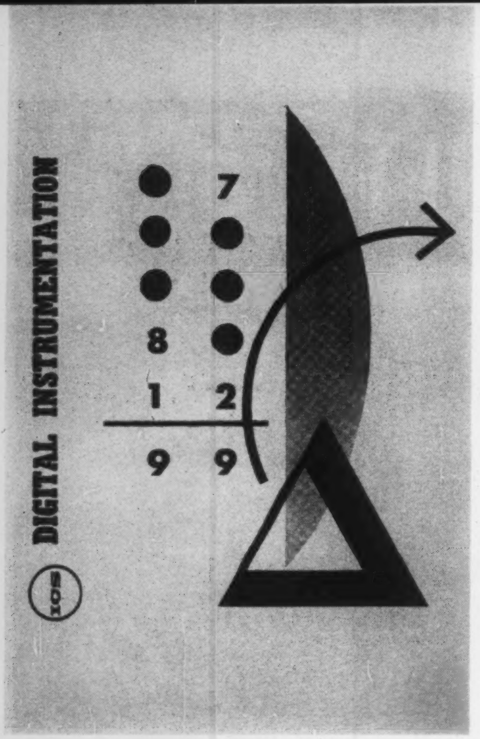


Digital Systems by Symbolic Logic

Circuits for counting, computing, comparing, testing, performing arithmetic or calculus operations, or operating as flip-flops, pulse pattern generators, etc., can be quickly designed by use of symbolic logic, Boolean algebra, and logic charts.

ROBERT BROOKS, Computer Control Co., Inc.

LOGIC CHARTS offer a simple, quick way to visualize and note logic statements and circuits, to compare them for equivalence or contradiction, and to implement them by use of available circuitry. Fig. 1 shows a 2-variable chart for several basic logic assertions. In the two-variable chart the possible conditions of input A (0 or 1) are shown at the left of the box; the possible conditions of B are listed at the top. The boxes are numbered 1, 2, 3 and 4 for identification. The condition A = 0 holds for boxes 1 and 2; the condition A = 1 holds for boxes 3 and 4. The four possible conditions of A and B are represented by the four squares.

Shading in a box means that the condition exists. Thus the assertion A (the statement A exists) is indicated by shading in boxes 3 and 4. Both boxes are shaded because the condition of B has no bearing on the simple assertion A. The logic charts shown in Fig. 1 repeat the statements made beneath them.

A *three-variable logic chart* is shown in Fig. 2. All combinations of any three bistable variables can be represented by the eight squares. This sequence of charts builds up the expression $(A \cdot B)\ v\ C$ in the following manner: First shade in appropriate squares to express each element on separate charts (such as done in Fig. 2) for $\bar{A}$, B, and C. When the input statements are joined by an *and*, shade in only those squares that were shaded on both input charts. This is shown for the $\bar{A} \cdot B$ chart. Represent an *or* statement by shading in *all* squares that were shaded on the individual charts. The final chart shows $\bar{A} \cdot B\ v\ C$.

Implementing the Logic Chart

Each square on the logic chart represents an output for the given inputs. For example, square 1 in Fig. 1 represents $\bar{A} \cdot \bar{B}$; square 2 represents $\bar{A} \cdot B$; square 3 represents $A \cdot \bar{B}$; square 4 represents $A \cdot B$. These 4 actions can be implemented by the four *and* gates and 1 buffer (Fig. 3). Thus Fig. 3 represents the implementation of a 2-variable logic chart. For example, $\bar{B}$ is realized simply by selecting gates 1 and 3.

The logic chart can be used for circuit design. Each square on the chart can be implemented by one *and* gate, as shown in Fig. 3. Each gate represents one square on the logic chart. Hence, the logic represented by a logic chart can be implemented simply by selecting the corresponding gate or gates.

FIG. 1. TWO-VARIABLE logic chart expresses all possible logical conditions of the bistable variables A and B via shaded areas. Shown are conditions A (A exists); B (B exists); $\bar{A}$ (A does not exist); $\bar{B}$ (B does not exist); A•B (A and B exist); A v B (A or B exists); $\bar{A}$•$\bar{B}$ (not A and not B exist).

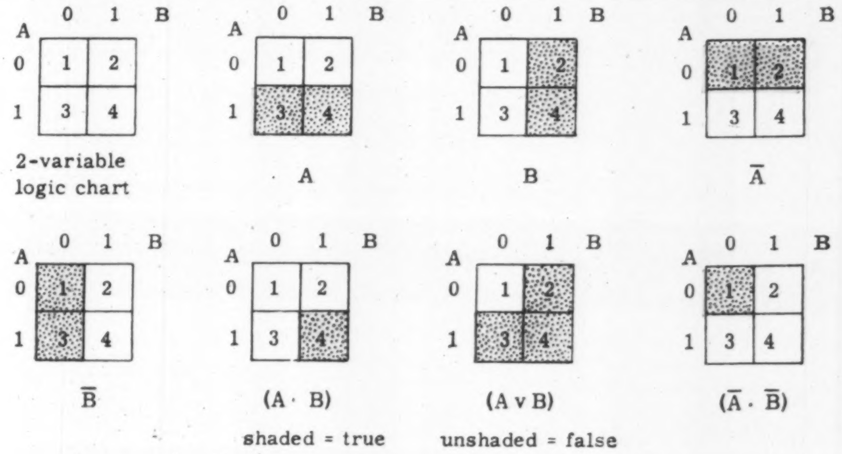
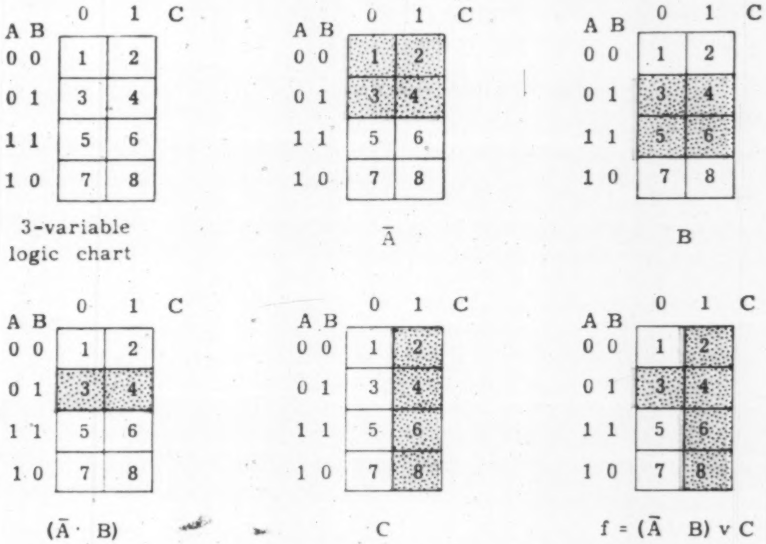


FIG. 2. THREE-VARIABLE logic chart. As there are 8 possible combinations of 3 bistable variables, chart has eight squares to represent all possible combinations.



Note that the falsity of a statement can be represented simply by implementing the *unshaded* areas of the logic chart. Thus any one problem can be solved either by implementing the shaded areas by selecting the proper gates, or by implementing the unshaded areas and inverting the output. Hence the gates can be used to represent either the shaded or the unshaded squares of the chart—and an inverter can be used at the output to invert the signal to give an indication of either the truth or the falsity of the given logic.

Note that four two-input gates can implement a 2-variable logic chart. Similarly, eight 3-input gates can implement all the logic on a 3-variable logic chart. Fig. 4 shows how the logic developed in Fig. 2 is satisfied by use of five of these gates.

As there are only 8 squares in a logic chart involving 3 variables, and as either the shaded or unshaded squares can be used to implement the logic, four is the

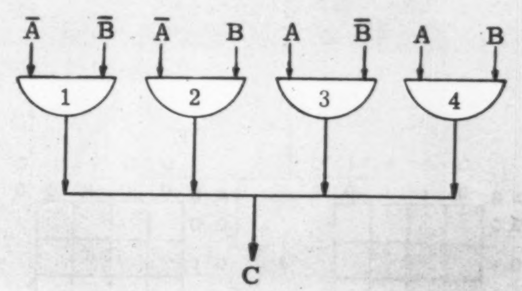


FIG. 3. FOUR *and* **GATES** permit the solution of all logical possibilities in a 2-variable logic chart. Each gate represents one square of the 4-square logic chart.

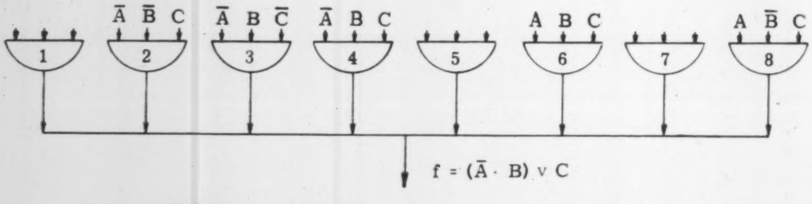


FIG. 4. EIGHT *and* **GATES** can implement a 3-variable logic chart. Selecting gates 2, 3, 4, 6, and 8 satisfies the logic developed in Fig. 2.

		0	1	1	0	C
		0	0	1	1	D
A	B					
0	0	1	2	3	4	
0	1	5	6	7	8	
1	1	9	10	11	12	
1	0	13	14	15	16	

FIG. 5. FOUR-VARIABLE logic chart has 16 possible combinations of inputs.

maximum number of gates required for any 3-variable logic. For example, in Fig. 4, the logic could have been solved by use of gates 1, 5 and 7, and then inverting the output. For this reason, a 4-gate package can replace the 8-gate system of Fig. 4, and can represent all 3-variable functions. In fact, many 3-variable functions can be represented by using three or fewer gates.

Four-Variable Functions

The logic chart for a four-variable function is shown in Fig. 5. On this chart all possible functions of four variables can be defined. There are 65,536 logic combinations. To implement, each square of this chart would require one 4-leg gate. Implementing all squares separately would thus require sixteen such gates (or eight by using the inversion technique described). However, it is possible to lessen the number of gates required by representing blocks of adjacent squares with a single gate. In defining such blocks, the first and last columns of the chart and the top and bottom rows can be considered adjacent.

If shaded or unshaded squares are grouped together they can be implemented as follows: (A) Eight adjacent squares forming a 2 x 4 rectangle can be represented by a 1-leg gate because the logic statement will contain only one term. For example, the 8-square area in Fig. 6 is simply $\bar{C}$. (B) Four adjacent squares forming either a 2 x 2 or a 4 x 1 rectangle can be represented by a 2-leg gate because the statement will contain only two terms, as shown in Fig. 6. (C) Two adjacent squares sharing the same row or column can be represented by a 3-leg gate because the fourth variable will not appear in the statement, as shown. (D) Remaining single squares require a 4-leg gate for representation because the statement will contain all four terms.

Implementation with Gating Packages

It has been mentioned that only four gates are required to implement any statement involving 3-variable logic. Fig. 7 shows a gating package comprising four *and* gates, one *or* gate buffer, a delay unit, and an inverter. This package is designed to operate on pulses having a 1-megacycle repetition rate—that is, one operation is performed every microsecond. The result is carried over to the next pulse period. This basic package can be used to implement many electronic and computing functions, such as serial addition, parallel addition. serial addition-subtraction, multiplication, division, calculus operations, development of flip-flop operation, binary flip-flop operation, forward-backward counting, binary counting, pulse pattern generations, etc., as will be described in this and following discussions.

Flip-Flop

The flip-flop is a familiar bistable element. The simplest form of a flip-flop is one that is turned ON by applying a pulse S (set pulse) and turned OFF by applying a pulse R (reset pulse); i.e., once the flip-flop has been turned on by the set pulse, it should remain on (true) until it is turned off by the reset pulse. Conversely, it should remain off (false) until it is turned on again by a set pulse.

If symbolic logic is employed, the expression for this

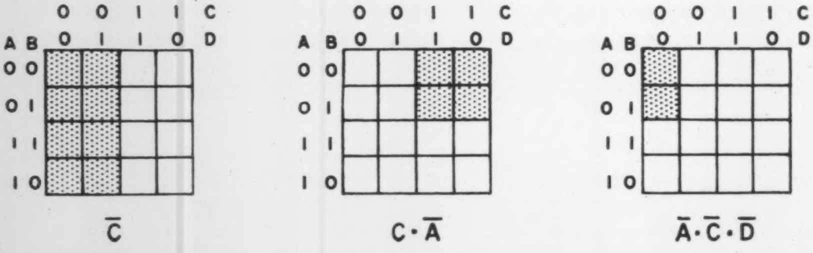


FIG. 6. GROUPS OF ADJACENT squares can be considered as simple gates—an eight-square group by a 1-leg gate, four squares by a 2-leg gate, and 2 squares by a 3-leg gate.

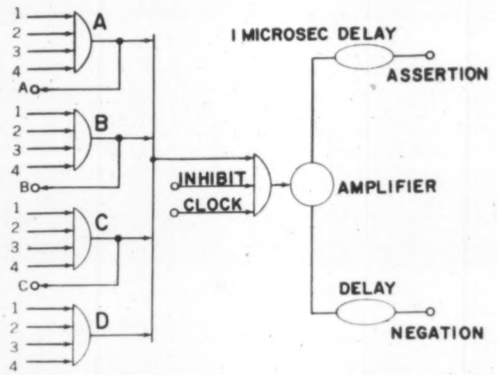


FIG. 7. GATING PACKAGE (T-PAC) includes four 4-leg *and* gates, 1 *or* gate, an inverter (amplifier) and delay units. Clock pulses tell gate when to examine and respond to input signals. Inhibit signal is used to control entire unit. Logic signal cannot reach output if inhibit signal is not present.

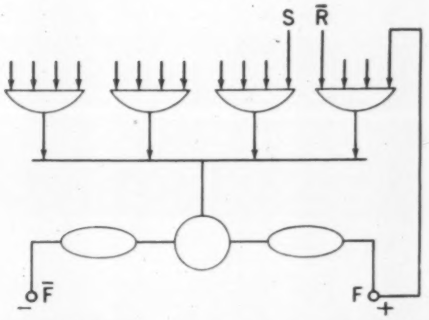


FIG. 8. FLIP-FLOP results from implementing $S \vee (\bar{R}\cdot F)$. The logic statement simply says that the device operate (have an output) either (1) when a set pulse is applied or (2) when operating (F exists) without a reset pulse. These two conditions define a flip-flop.

device is $S\ v\ (\bar{R}\cdot F)$, where S is the set pulse, F is the plus output of the flip-flop, R is the reset, and $\bar{R}$ is used to mean "no reset pulse." Hence, the logic statement $F = S\ v\ (\bar{R}\cdot F)$ says that this device shall have a true output after it receives a set pulse and shall continue to have a true output until a reset pulse is received. If the statement is examined, it can be seen that the S pulse creates the true pulse F and that the term $(\bar{R}\cdot F)$ maintains this true state. Whenever an R pulse is received, the latter term becomes false, causing the entire statement to be false, hence turning off the device. Thus, a flip-flop has been created. The flip-flop connections used on a T-PAC are shown in Fig. 8.

Binary Flip Flop

A binary flip-flop is a stable device that changes state each time an input pulse B is applied. The symbolic logic statement for this is $F' = (B\cdot\bar{F})\ v\ (\bar{B}\cdot F)$. The symbol F′, read "F delayed one pulse period," distinguishes the output of a T-PAC from its inputs, which occur one microsecond earlier. The characteristic of a binary flip-flop is that if it is off (F′ false and $\bar{F}'$ true), a pulse B will turn it on (make F′ true). The flip-flop will remain on ($\bar{B}\cdot F$ true) until another pulse B is received. Conversely, if the device is on (F′ true and $\bar{F}'$ false), a pulse B will turn it off until another pulse B is received. Fig. 9 shows the simple implementation of this logic.

Set-Reset and Binary Flip-Flop

An extension of the flip-flop and binary flip-flop is a bistable device that is turned on by a set pulse, turned off by a reset pulse, and has its state changed by the application of the B pulse. The symbolic logic statement for this is:

$$F = S\ v\ (B\cdot\bar{F})\ v\ (\bar{B}\cdot\bar{R}\cdot\bar{F})$$

The appropriate connections are shown in Fig. 10.

To be Continued

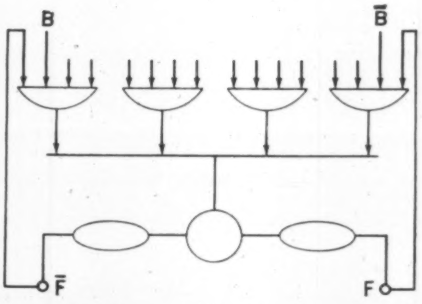


FIG. 9. SYMBOLIC expression for a binary flip-flop is $F' = (B\cdot\bar{F}) \vee (\bar{B}\cdot F)$. This simple circuit satisfies the logic.

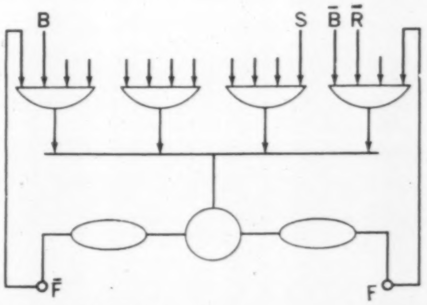
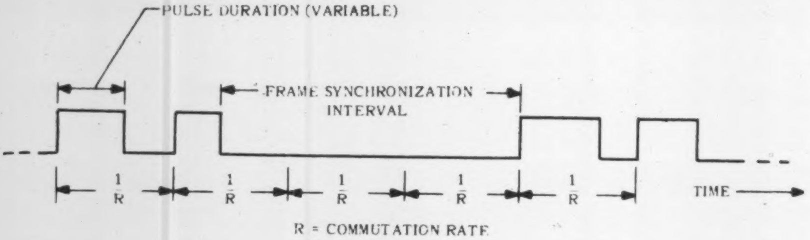


FIG. 10. LOGIC OF a set-reset binary flip-flop is $F = S \vee (B\cdot\bar{F}) \vee (\bar{B}\cdot\bar{R}\cdot\bar{F})$.



PDM / FM Standards

PULSE DURATION MODULATION (PDM) systems are intended for use where a strictly time-division multiplex system can meet the bulk of the telemetry requirements of a given application. They have sometimes been called pulse-width modulation (PWM). A relatively large number of information channels can be accommodated, but at a relatively low frequency-response capability in comparison with the subcarrier channels of the FM/FM system. Although the specifications to be given are based on previous experience with mechanical commutators, nothing in this standard is intended to prevent the use of electronic commutation methods.

Pulse Duration Modulation Specifications

The following are the specifications for the pulse duration modulated signal:

Number of samples per frame**	30	45	60	90
Frame rate (frames/sec.)	30	20	15	10
Commutation rate (samples/sec.)***	900	900	900	900

The information being transmitted in each channel shall determine the duration of the corresponding pulses. The relation between information magnitude and pulse duration should, in general, be linear.

Minimum pulse duration (zero level information)—90 ±30 microseconds

Maximum pulse duration (maximum level information)—700 ±50 microseconds

Pulse rise and decay time (measured between 10% and 90% levels)—10 to 20 microseconds (constant to ±3 microseconds for a given transmitting set)

The time interval between the leading edges of successive pulses within a frame shall be uniform from interval to interval and shall be constant within plus or minus 25 microseconds. This time interval shall have a nominal period equal to one divided by the total sampling rate.

The commutator speed (or frame rate) shall not vary more than plus 5% to minus 15% from nominal.

Frame synchronization of the receiving station shall be provided for by leaving a longer than normal time gap in the train of pulses transmitted. This gap shall be the same as that normally occupied by two successive data channel pulses. A representation of the pulse train waveform is shown in the illustration.

Radio-Frequency-Carrier Specifications

The following are the specifications for the radio-frequency carrier and its modulation:

Radio Frequency: 216 to 235 megacycles/sec. The specific frequency assignment in this band shall be obtained by negotiation with the pertinent test range. Because up to approximately 0.2 megacycle/sec bandwidth may be occupied by a PDM/FM telemetry signal, appropriate spacing between adjacent r-f channels must be provided. The extent of the guard bands required will be determined by the operating conditions existing at the individual test ranges.

Stability: The r-f carrier frequency shall be stable to within ±0.01%.

Type of R-F Modulation: Frequency modulation.

R-F Deviation: ±25 to ±45 kilocycles/sec.

Power: 100 watts maximum, depending on distance and propagation problems; no more should be used than that necessary to achieve reliable transmission.

Spurious Signal Radiation: The radiated power of harmonics and all other spurious signals shall be 60 db or greater below the power level of the fundamental.

Polarization: If a circularly polarized transmitting antenna is used on a missile or aircraft, the signal transmitted to the rear, or downward, shall be right hand polarized (by I.R.E. definition). Any use of circularly polarized transmitting antennas should be coordinated in advance with the test range involved in order to insure compatibility with receiving antennas.

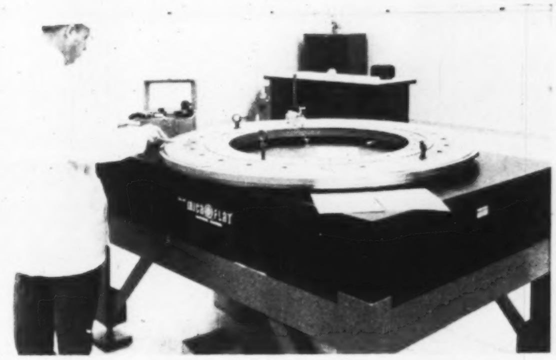
---

*Abstracted from IRIG Document 103-56

**The number of samples per frame available to carry information is two less than the number indicated because the equivalent of two samples is used in generating the frame synchronizing pulse.

***Commutation rate is equal to the frame rate multiplied by the number of samples per frame.

OPTICAL STANDARDS and Metrology laboratory features controlled environment.



GEAR AND BEARING assembly on granite surface plate being checked for temperature stabilization.

METROLOGY LABORATORY

GLENN W. MALME
Western Gear Corporation

THE WESTERN GEAR Optical Standards and Metrology Laboratory is located in the Quality Control building at Lynwood. This slightly pressurized room is entered through an air lock. Temperature is controlled at 68°F ±1° (the internationally accepted calibration and measuring temperature). The importance of temperature, when taking accurate measurements, is often underestimated. For example, if a plug gauge is held in the hand for only five seconds, the slight extra heat transmitted will expand it a measurable amount. The humidity of the room is held at a constant value below 60%.

Air cleaning is furnished by the new Cambridge "aerosolve" filtering system. The lab is furnished with 3600 cfm of dehumidified air with an initial duct velocity of 1400 fpm through a constant straight-run section. Four 4-way diffusers are equally spaced in the length of the room. Five isolated massive concrete bases serve as isolated platforms for optical instruments and surface plates, thus isolating building movements from measurements.

Communication is maintained by an intercom system.

Personnel wear nylon smocks and caps. Gloves are worn when any adverse chemical reaction may affect a part of a piece of equipment. Shoes are cleaned by a mechanical cleaning mat in the air lock. The room has a built-in vacuum cleaning system. All material is prepackaged or vacuumed before entering the room.

Each piece of equipment was chosen for a particular phase of checking. For instance, optically-ground polygons are used for checking angular spacing errors of individual gears, gear trains, dividing heads and rotary tables. Auto collimators and theodolites also are used. Other optical accessories include first-surface mirrors, spindle mirrors, target telescopes, optical height gages, optical squares, interference microscopes, optical plates and interferometers. All instruments are cataloged and stored in glass cases.

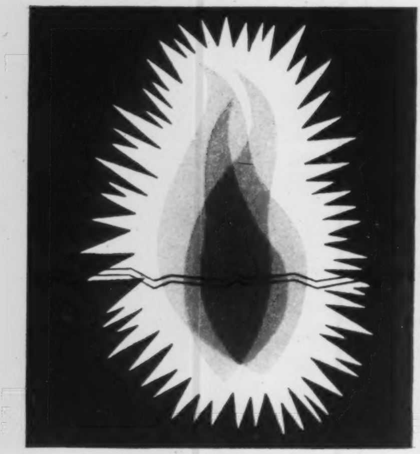
All equipment is calibrated and verified to nationally accepted standards on a schedule. Certification and calibration records are maintained.

Metrology Laboratory Equipment

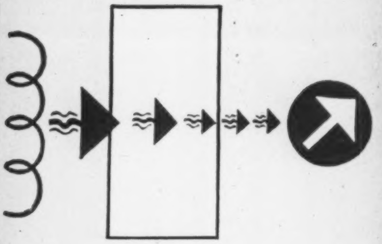
Quantity	Description and Accuracy
2—	T-3 Theodolite (Wild). Accuracy of circle reading 0.2 sec.
2—	Autocollimator (Leitz). 30 minute range reading accuracy of 1/10 seconds
2—	Comparison Autocollimator (Davidson D-600). 120 second range reading accuracy of 1/10 sec.
1—	Optical Square (Leitz). Calibrated to 1/10 sec.
1—	24-Sided Polygon (Hilger and Watts). Calibrated to 1/10 sec.
1—	5-Sided Polygon (Davidson). Calibrated to 1/10 sec.
1—	3-Angle Prism (Davidson D-611). Calibrated to 1/10 sec.
1—	90° Optical Square (Davidson D-613). Accurate to 2/10 sec.
1—	Spindle Mirror (Davidson D-622). Flat to 1/4 wavelength
1—	Plane Parallel 90° Adjustable Mirror (Davidson D-616). Accuracy to 1/10 sec parallel
1—	Microhygrograph (Serdex Type HGS-MHY-1). Accuracy 1% full scale
1—	Interference Microscope (Carl Zeiss). Magnification to 600-X
1—	Dividing Head (Carl Zeiss). Reading accuracy 3 sec.
1—	Recording Thermometer. Range 60 to 85° F. 1/5 degree accuracy
1—	Mikro-Kator Gauge (Johansson). Accuracy to 0.000002"
1—	Air Gauge (Precisionaire). Accuracy of bore diameters 0.00001"
1—	1" to 37" Optical Height Gauge (Webber). Accurate to 0.000025"
1—	Super Height Check (Brown & Sharp). Accurate to 0.000025"

CIRCLE 64 ON READER-SERVICE CARD →

MSA Instruments apply all these principles



Catalytic Combustion

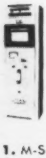


Infrared Analysis

Depolarization

INSTRUMENT DIVISION
Mine Safety Appliances Company
Pittsburgh 8, Pennsylvania

1.



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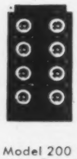

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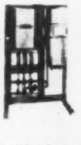


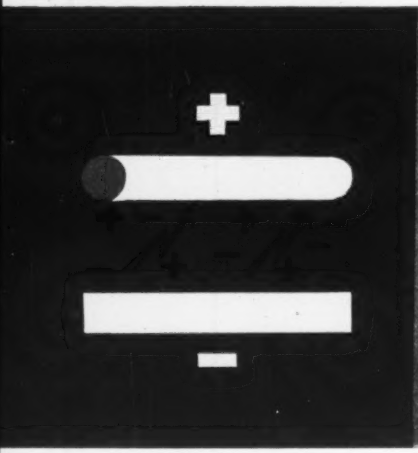
8.

9.

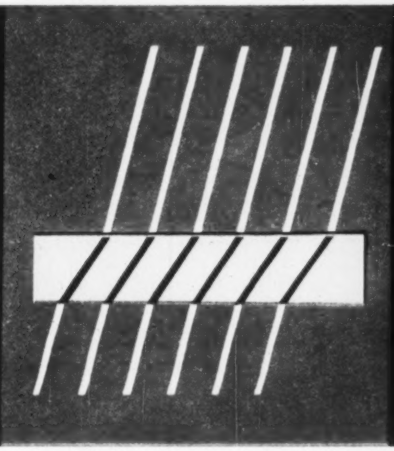
1. M-S-A® LIRA® Infrared Analyzer Model 200 **2.** M-S-A® LIRA® Infrared Analyzer Model 300 **3.** M-S-A® Inert Gas Analyzer **4.** M-S-A® Combustible Gas Analyzer **5.** M-S-A® Thermatron Analyzer **6.** M-S-A® Oxygen Indicator **7.** M-S-A® Water Vapor Recorder **8.** M-S-A® BillionAire* Analyzer **9.** M-S-A® Process Refractometer

*Trademark

for dependable process stream analysis



Ionization

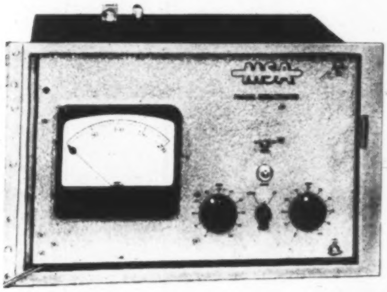


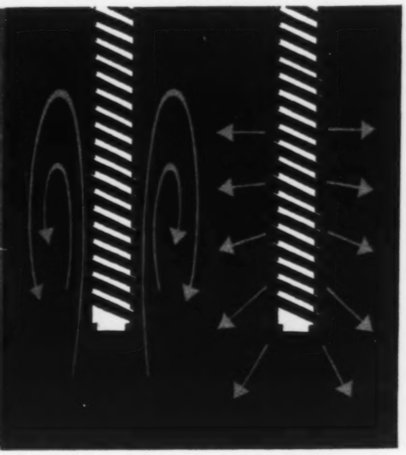
Refraction: Now MSA packages the principle of light refraction for continuous measurement of organic and inorganic liquids.

The new M-S-A® Process Refractometer shown below, compares the refractive index of a stream with a constant standard. Controls quality in either stream or batch processes. Converts to new problems quickly and easily.

MSA has been supplying industry with similar "brains" for gas analysis since 1922. So, we're not newcomers. Our people are competent professionals. And so are our instruments. Both are extremely articulate when it comes to process stream analysis.

There are many MSA approaches to measuring gas concentrations. From the simplest to the most sophisticated. Most of these approaches stem from the principles symbolized above. Write us for instrument literature on the new M-S-A Process Refractometer or any of our other process stream analyzers.





Thermal Properties

Atomic Length Standards

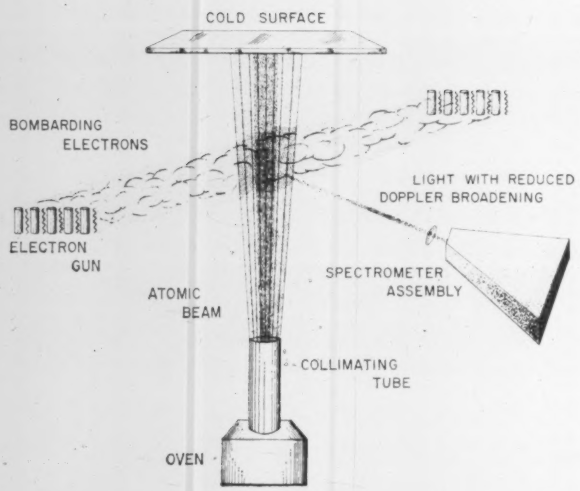


FIG. 1. ATOMIC-BEAM principle used to produce narrow emission lines in research to improve wavelength standards. Atoms emerging from the oven emit radiation which is viewed at right angles to the direction of motion. In this way the broadening due to the movement of atoms toward and away from the observer is reduced considerably.

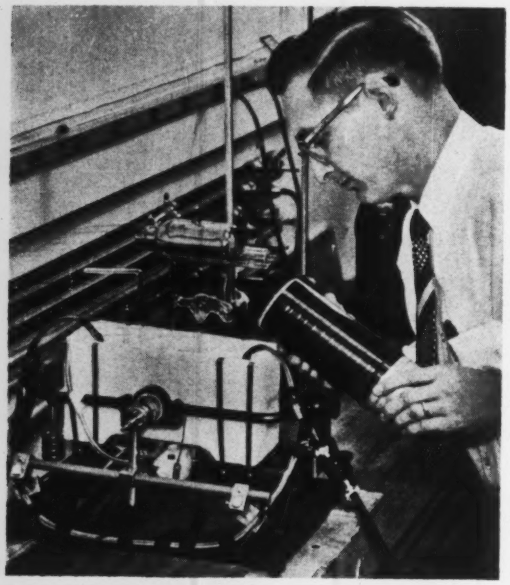


FIG. 2. IN ATOMIC BEAM, atoms emerge from heated mercury cell in oven below box. Titanium ion pump (above apparatus) maintains a vacuum of 10^{-7} mm Hg in mercury chamber.

←—— CIRCLE 64 ON READER-SERVICE CARD

TWO promising approaches for improving length standards are under study at the National Bureau of Standards. These are the *atomic beam* and the *Zeeman absorption filter*.[1] Both have proved successful in producing very narrow lines whose wavelengths can be precisely determined.

Attempts to define the basic unit of length, the meter, in terms of an unchanging property of nature have been under way for many years. The present standard, the distance between two engraved lines on a platinum-iridium bar, not only lacks the reproducibility and availability that a standard as fundamental as length should have, but, being material, it can be altered or destroyed. As early as 1892, Michelson attacked this problem by measuring the meter in terms of a wavelength of light. The same approach forms the basis for the presently proposed international standard, the orange line from krypton-86. Sources making use of this isotope can furnish standards which should be reproducible to 1 part in 10^8—a great improvement over the precision obtainable with the meter bar.

Atomic-Beam Devices

The precision possible with present wavelength standards is limited by Doppler broadening of spectral lines—an effect due to the random motion of the emitting atoms toward and away from the observer. K. G. Kessler, R. L. Barger, and W. G. Schweitzer, Jr., of the Bureau's length laboratory, and K. W. Meissner of Purdue University, have found a successful solution to this problem in atomic-beam devices [2, 3]. Atomic-beam techniques, developed many years ago for the study of hyperfine structure in atomic spectra, decrease Doppler broadening by selecting atoms traveling at right angles to the line of sight (Fig. 1). The drawback, however, is that the light intensity is low because the device must be operated at low densities to avoid collisions between atoms and to maintain a collimated beam.

References

1. Kessler, Karl G., and Schweitzer, Walter G., Jr., "Zeeman-split Absorption Lines as Very Narrow Pass Filters," *Journal Optical Soc. Amer.*, Vol. 49, page 199, 1959.

2. Kessler, Karl G., Barger, Richard L., and Schweitzer, Jr., Walter G. "Atomic-beam Sources and the Standard of Length," *Trans. I.R.E.* (in press).

3. Kessler, Karl G., Barger, Richard L., Schweitzer, Jr., Walter G., "Mercury Atomic Beams for Metrology," *Proc. Symposium of Interferometry*, National Physical Laboratory, 1959 (in press).

COMPRESSED-AIR SURVEY

ONE thousand readers of *INSTRUMENTS AND CONTROL SYSTEMS* were questioned about the size, type, and use of air supplies in their plants or factories. Detailed answers were received from 259, of which 88% reported that one major use of their clean compressed air was in instrumentation. The total number of compressors being operated by these respondents total approximately 2000.

Here is the way these compressors are being operated, including accessories, operating conditions, maintenance factors, pressures, dewpoints, etc.

STUDY DETAILS

Questionnaires Mailed	1,000
Replies Received	259
Percent Return	25.9
Number reporting instrumentation as a major use of clean compressed air	229
Number not reporting instrumentation as a major use of clean compressed air	16
Total reporting use of compressed air	245
Number reporting no use of compressed air	4
Number not answering the question "Do you use compressed air?"	10

Industrial Breakdown of Respondents

Chemical Industry	71
Pulp and Paper	50
Petroleum	25
Design and Construction Companies	10
Plastics	9
Petrochemical	9
Food Products	8
Pharmaceuticals	8
Nylon and Rayon	7
Public Utility	6
Steel Manufacture	6
Pipe Lines	5
Breweries	4
Rubber	4
Aircraft	3
Electronic Equipment	3
Building Material and Floor Covering	3
Textiles	2
Atomic Energy Commission	2
Non-metallic Minerals	2
Non-ferrous Metals	2
Glass Products	1
Nuclear Products	1
Power Reactor	1
Printing	1
TOTAL	243

Report by C. F. Goldcamp, Manager, Research and Development, Instruments Publishing Co.

Footnote to all tables: As all respondents did not answer all questions, the total number of answers in each category is less than 259.

Position of Respondents

Instrument Engineer	84	38%
Instrument Supervisor	17	7%
Instrument Superintendent	9	4%
Instrument Foreman	9	4%
Instrument Technician	8	4%
Plant Engineer	6	3%
Engineer (no field indicated)	16	7%
Titles common to 4 or fewer respondents	74	33%
TOTAL	223	100%

Field of Activity

Control	6	3%
Measurement	3	2%
Instrumentation	12	5%
Instrument	127	57%
Maintenance	11	5%
Plant	11	5%
Utilities	4	2%
Construction	3	2%
Miscellaneous	20	8%
No field indicated	26	11%
TOTAL	223	100%

Position of Responsibility

Engineer	127	57%
Designer or Draftsman	2	1%
Superintendent	13	6%
Supervisor	27	12%
Foreman	22	10%
Lead or Leader	7	3%
Mechanic	3	2%
Technician	12	5%
Miscellaneous	10	4%
TOTAL	223	100%

Question1. How many compressors are in use in your plant or company?

1 to 3	56	25%
4 to 6	52	23%
7 to 10	39	17%
11 or more	77	35%
All Answers	224	100%

Question 2. What is the approximate total compressor output in your plant?

0 to 499 cfm	32	18%
500 to 999 cfm	20	12%
1,000 to 1,499 cfm	19	12%
1,500 to 1,999 cfm	8	4%
2,000 to 2,499 cfm	13	7%
2,500 to 2,999 cfm	6	3%
3,000 to 3,999 cfm	12	7%
4,000 to 4,999 cfm	12	7%
5,000 to 5,999 cfm	8	4%
6,000 to 7,999 cfm	10	6%
8,000 to 9,999 cfm	8	4%
10,000 to 14,999 cfm	6	3%
15,000 to 19,999 cfm	6	3%
20,000 to 29,999 cfm	4	2%
30,000 to 39,999 cfm	2	1%
40,000 to 49,999 cfm	8	4%
50,000 cfm and over	5	3%
All Answers	179	100%

Question 2a. What pressure is system to maintain?

20 to 29 psi	2	1%
30 to 39 psi	7	3%
40 to 49 psi	4	2%
50 to 59 psi	16	7%
60 to 69 psi	13	6%
70 to 79 psi	9	4%
80 to 89 psi	19	9%
90 to 99 psi	36	16%
100 psi	74	33%
Over 100 psi	45	19%
All Answers	225	100%

Question 2b. What is the minimum dew point you require for your pneumatic equipment?

	Indoors		Outdoors	
40°F and over	32	30%	8	7%
30°F to 39°F	13	13%	3	3%
20°F to 29°F	14	13%	17	15%
10°F to 19°F	6	5%	11	10%
0°F to 9°F	11	11%	17	15%
0°F to — 9°F	1	1%	1	1%
—10°F to —19°F	9	8%	15	12%
—20°F to —29°F	5	5%	13	11%
—30°F to —39°F	2	2%	8	7%
—40°F to —49°F	8	6%	12	11%
—50°F and under	—	0%	3	3%
Environmental	3	3%	2	2%
Below environmental	2	2%	2	2%
1,000 ppm	1	1%	1	1%
All Answers	107	100%	113	100%

Question 2c. Is the system's demand continuous?

Yes	191	85%
No	29	13%
Yes and No	4	2%
All Answers	224	100%

Question 2d. Is the system: Automatic, Semi-automatic, Manual?

Automatic	143	66%
Semi-automatic	43	20%
Manual	11	5%
Automatic and Semi-automatic	8	4%
Automatic and Manual	3	1%
Semi-automatic and Manual	—	—
Automatic, Semi-automatic, and Manual	10	4%
All Answers	218	100%

Question 2e. Is installation Indoors or Outdoors?

Indoors	168	74%
Outdoors	22	10%
Indoors and Outdoors	35	16%
All Answers	225	100%

Question 2f. Is Installation Explosion-proof?

Yes	66	30%
No	142	64%
Yes and No	14	6%
All Answers	222	100%

Question 3. What Type Compressors are used in your plants?

Oil-lubricated	106	48%
Carbon ring	22	10%
Water seal	2	1%
Oil and carbon ring	59	28%
Oil-lubricated and water seal	12	6%
Carbon ring and wate rseal	1	0%
Oil-lubricated, carbon ring and water seal	14	7%
All Applicable Answers	216	100%

Question 4. What are your major uses of clean compressed air? 245 respondents indicated use of air as follows:

Instrumentation	229	94%
Operating machinery	130	63%
Paint spray	80	33%
Air Tools	118	48%
Process Air	141	58%
Gaging	21	9%
Other	22	9%

Question 5. Is a separate compressor and distribution system used for instrument air?

Yes	94	42%
No	99	44%
Yes and No	28	14%
All Answers	221	100%

Question 6. What department in your plant is responsible for (maintenance) instrument compressors?

Instrument Department			28	14%
Maintenance Department			85	40%
Mechanical Department			27	13%
Electrical Department			5	2%
Other			64	31%
Utilities (or Utility)	12	6%		
Power (or Steam, Boiler or Fuel)	38	19%		
Operating or Production (or Processing)	9	4%		
Miscellaneous	5	2%		
All Answers			209	100%

Question 7a. Approximately how much air is required for instrumentation?

0 to 99 cfm	34	19%
100 to 199 cfm	23	13%
200 to 299 cfm	18	10%
300 to 399 cfm	20	11%
400 to 499 cfm	7	4%
500 to 599 cfm	14	8%
600 to 699 cfm	7	4%
700 to 799 cfm	4	2%
800 to 899 cfm	6	3%
900 to 999 cfm	2	1%
1,000 cfm	10	6%
Over 1,000 to under 1,500 cfm	1	0%
1,500 cfm	5	3%
Over 1,500 to under 2,000 cfm	3	2%
2,000 cfm	8	4%
Over 2,000 to under 2,500 cfm	—	—
2,500 cfm	6	3%
Over 2,500 to under 3,000 cfm	—	—
3,000 to 3,999 cfm	3	2%
4,000 to 4,999 cfm	2	1%
5,000 to 5,999 cfm	4	2%
6,000 cfm and over	3	2%
All Answers	180	100%

Question 7b. What is approximate air pressure required for instrumentation?

0 to 9 psi	1	0%
10 to 19 psi	8	4%
20 to 29 psi	31	17%
30 to 39 psi	7	4%
40 to 49 psi	14	8%
50 to 59 psi	17	10%
60 to 69 psi	24	14%
70 to 79 psi	9	5%
80 to 89 psi	12	7%
90 to 99 psi	17	10%
100 psi	33	18%
Over 100 psi	5	3%
All Answers	178	100%

Question 8. Do you decontaminate your air at the: —

Point of use	34	16%
Main source	52	24%
Both	130	60%
All Answers	216	100%

Question 9. Is one of the following types of dehumidifiers or filters installed in your compressed air system?

	Instrument Air		Plant Air	
Aftercooler only	10	5%	83	46%
Pipe line filter only	18	10%	10	6%
Aftercooler and pipe line filter	32	16%	52	29%
Aftercooler and desiccant dehumidifier	57	29%	9	6%
Aftercooler and water-cooled dehydrator	9	5%	6	3%
Electrostatic	—	—	2	1%
Aftercooler, pipe line filter & desiccant	62	31%	10	6%
Other	8	4%	7	3%
All Answers	196	100%	179	100%

Question 10. Do you order filters by: —

Pipe size	19	9%
Capacity and Pressures	126	58%
Both	73	33%
All Answers	218	100%

Question 11. To what ambient temperature is system exposed?

	Single Answer		Double Answer			
			High		Low	
140°F and over	1	2%	7	4%	0	
130°F to 139°F	—	—	6	4%	0	
120°F to 129°F	3	5%	24	16%	0	
110°F to 119°F	1	2%	21	15%	0	
100°F to 109°F	9	13%	62	42%	0	
90°F to 99°F	5	8%	20	13%	2	1%
80°F to 89°F	6	9%	4	3%	5	3%
70°F to 79°F	11	17%	3	2%	15	10%
60°F to 69°F	3	5%	—	—	14	9%
50°F to 59°F	—	—	—	—	11	8%
40°F to 49°F	—	—	1	1%	7	5%
30°F to 39°F	1	2%	—	—	15	10%
20°F to 29°F	—	—	—	—	12	8%
10°F to 19°F	3	5%	—	—	17	11%
0°F to 9°F	2	3%	—	—	21	15%
0°F to —9°F	1	2%	—	—	3	2%
— 10°F to — 19°F	2	3%	—	—	16	11%
— 20°F and under	4	6%	—	—	10	7%
Indoor	2	3%				
Outdoor	9	13%				
Both	1	2%				
All Answers	64	100%	148	100%	148	100%

Question 12. Is cooling water available?

Yes	202	95%
No	8	3%
Yes and No	4	2%
All Answers	214	100%

Question 13. What are your sources of water supply?

			Temperature (Averages)	
			Minimum	Maximum
Well	62	27%	56°F	65°F
Cooling tower	42	18%	59°F	88°F
City water	51	22%	48°F	73°F
Filtered river or lake	65	28%	39°F	78°F
Other	12	5%	51°F	74°F
All Answers	232	100%	49°F	75°F

Question 14. What contaminant in compressed air presents the most serious problem in your air system?

Oil	84	38%
Water	82	37%
Carbon dust	11	5%
Dirt particles	19	9%
Rust	18	8%
Other	6	3%
All Answers	220	100%

Question 15. Do you use tubing supports?

Yes	208	90%
No	23	9%
Yes and No	2	1%
All Answers	233	100%

Acknowledgement is made of the assistance of Paul Hankison, President of Hankison Corporation and J. L. Zimmerman, Research Engineer, Nash Engineering Co., in the preparation and analysis of the survey.

PUBLISHER'S MESSAGE TO MANUFACTURERS OF PNEUMATIC EQUIPMENT:

Throughout all industry, wherever pneumatic instruments and control devices are used, clean dry air is essential. Here, the engineer in charge of instrumentation has significant influence in the selection of pertinent products and materials, such as:

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- Pipe Line Filters
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- Tubing Supports
- Tubing Troughs

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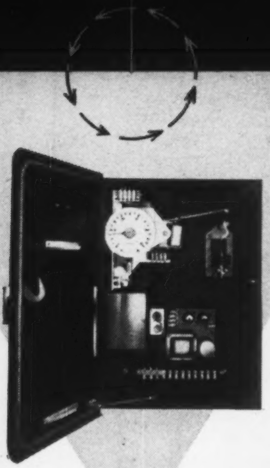
Flow	Upset contacts
Temperature	Limit switches
Linear motion	Deviation contacts
. . . and many others	. . . etc., etc., etc.



New Bristol Dyna-Servo Transducer uses same convenient panel-type packaging as regular instruments, adds new flexibility to instrument system design.

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It's the new Bristol Dyna-Servo Transducer, a high-torque, electronic servo unit that converts position or measurements into precision shaft angle . . . uses same highly accurate, service-proved electronic system as famous Bristol Dynamaster* potentiometer and bridge instruments . . . works with high-precision Bristol measuring elements, long known for accuracy, sensitivity, stability. Write for complete technical data on this new Bristol contribution to instrumentation flexibility. The Bristol Company, 113 Bristol Road, Waterbury 20, Conn.

******T. M. Reg. U.S. Pat. Off.* 9.27

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AUTOMATIC CONTROLLING, RECORDING AND TELEMETERING INSTRUMENTS

CIRCLE 65 ON READER-SERVICE CARD

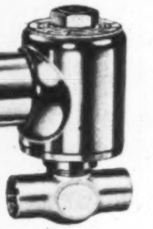
HOKE Flow Sheet 1

HOKE REPORTS ON FLUID CONTROL

A VALVE NAMED "DESIRE"

With apologies to Tennessee Williams, we really have produced a Solenoid Valve line based on *your* desires. We surveyed all the solenoid valve users we could find to determine what *you* wanted. The result is Hoke's "User Designed" Series 90 and 95, two-way and three-way, direct-acting solenoid valve line.

Thanks to you, we have much to brag about. Here's what we have been saying about these new valves: lightest weight – smallest size – no-hum operation – lowest temperature rise – lowest power consumption – stainless steel plunger – silver AC shading coils – easiest installation – packless construction – 360° rotatable housing – operates in any position.



We make them of forged brass or stainless steel, in 1/8" and 1/4" NPT size or JIC tube ends. There's a variety of AC and DC voltages. Class "A" coils are standard, but Class "H" are also available for temperatures above 212°F. For those with high insurance rates, we can supply explosion proof coil housings.

Now that we've bragged a bit, we must also apologize for our premature enthusiasm. We were so excited about this product that we stirred up a hornet's nest of interest before we were ready to deliver in quantity. Shipments were slow at the start, but now we can have any reasonable quantity of these "desirable" solenoid valves "on-stream" in your plant when you want them.

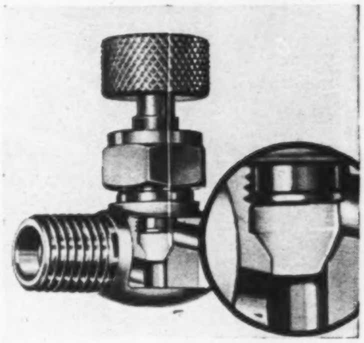
There's only one way to get conclusive performance proof – buy a valve. Ask for Bulletin SV-1159.

What Goes With What?

This is a question engineers and chemists are constantly asking each other. Not that we want to do away with this healthy interplay at the water cooler, but we have put together a slide rule that answers all these questions. It lists 22 metals and materials and their degree of resistance to 247 corrosive agents.

Got yours? Write now while there are a few (thousand) left.

HOKE'S NEW PLASTIC STEM TIPS END CHRONIC FAILURE PROBLEM



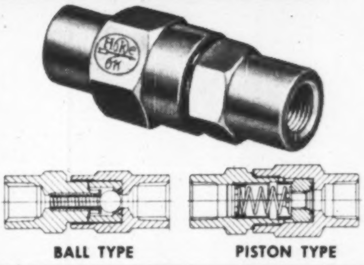
Galling and scoring valve seats plagued valve users and manufacturers for years, until somebody thought of using plastic stem points. This idea worked well at low pressures, but when the pressure increased – poof! – the valve blew its tip. Up to now, this problem had continued to bother valve makers.

Fortunately, a die-hard Hoke engineer insisted he could put a permanent plastic tip on a high pressure valve. We gave him his head and he gave us a plastic-tipped valve-stem (using either Kel-F or Nylon). His unique design incorporates a crimped metal shell that grabs the plastic tip and *really* holds!

Not satisfied with this monumental accomplishment, he proceeded to tackle leak problems at the stem packing. He put an O-ring seal on the stem and compressed it with a newly-designed Nylon collar. The collar serves a dual role, for it also prevents grit and other foreign matter from chewing up the O-ring. Valves of this new design have performed successfully up to 3500 psi. Our die-hard engineer not only ended galling, but also seat leakage, stem leakage and wear problems – all at one swoop.

There's only one feature about this new development that worries us – since we do not expect replacements we may have designed ourselves right out of the valve business! We make these little dandies of either forged brass, bar stock or 316 Stainless, with 1/8" and 1/4" male connections. Temperature limit is 400°F. For the complete story, write, wire, phone or we'll come see you.

Hoke "TECH-SPEC"



570 SERIES CHECK VALVES

Designed for gas or liquid service at pressures to 5000 psi. Ball and piston types for extremely effective leak-tight closure, coupled with minimum flow resistance. Ball types in 1/8" and 1/4" sizes; piston types in 3/8" and 1/2" sizes. Temperature limits, –40 to 200°F. Body materials are Brass or 303SS. End construction is interchangeable with any combination of inlet and outlet connections. O-ring seals are available.

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CIRCLE 66 ON READER-SERVICE CARD

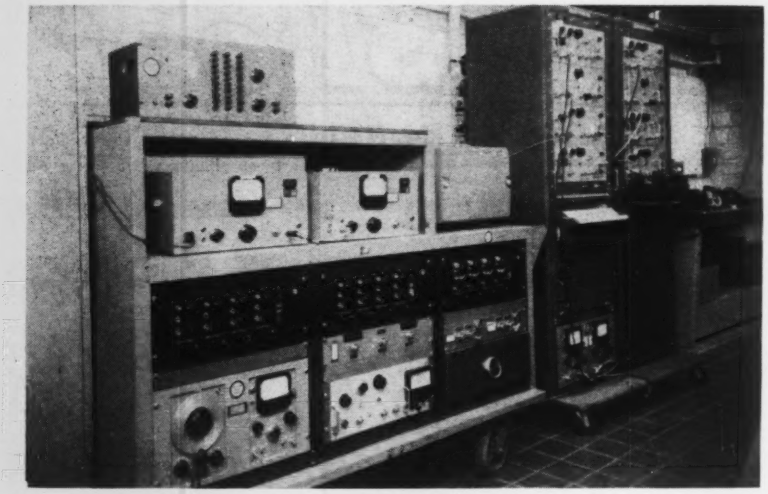


FIG. 1. PHOTOGRAPHIC AND DIRECT-WRITING recording equipment mounted for portability.

DYNAMIC

RICHARD H. CERNI
Small Aircraft Engine Dept.
General Electric

DYNAMIC MEASUREMENTS in aircraft gas-turbine development include recording of temperature, pressure, flow, speed, vibration, displacement, torque, position, voltage and current.

Direct-writing, photographic, and magnetic-tape recording is used, depending on the frequencies of interest. Fig. 1 and 2 show the recording systems. Fig. 3 shows a function-plotting system, essentially an x-y recorder for plotting temperature, pressure or flow angle against probe position across a flow passage. The response of this system is about 1 second.

Figs. 4, 5, and 6 show the accessories used with each type of recording, for each type of transducer.

Temperature

The most common dynamic temperature measurement is of exhaust gas, although turbine temperature also is measured often.

Copper-Constantan thermocouples are used for temperatures in the 0-600 F range and Chromel-Alumel thermocouples for the 0-2000 F range. All normal engine temperatures can be measured. Slow changes (up to 2 or 3 cps) in temperature can be measured, but rapid changes cannot with most high-temperature types of thermocouples. Over-all accuracy of dynamic temperature measurement is within ±3% of full scale, including error caused by thermocouple non-linearity. Resistance thermometer sensors are not used.

Figs. 3, 4 and 5 show the recommended systems for temperature measurement. Calibration is provided by an external semi-precision potentiometer, which provides simulated thermocouple voltages for given full-scale temperature settings.

Due to the low-level d-c signal generated by a thermocouple, and the subsequent high amplification, a-c pickup can cause hash to appear in the trace. Ideally, balanced input amplifiers with high common-mode rejection should be used. Filter networks or narrow-band preamps also relieve much of this trouble.

The reference junction may be in an ice bath or a closely controlled oven. If error due to temperature change at the reference junction is small, as it often is in high-temperature work, the reference junction is not required.

Pressure

Pressure is one of the easiest dynamic measurements to make because equipment for this has been so highly developed. Transducers available produce electrical output signals and are adapted for high-speed measurement. Pressures can be measured either single-ended or differentially by selection of the proper transducer. In engine work the range of measurement varies from 0-1 to 0-1,000 psi, and differentials from ±1 to ±50 psi. Average over-all expected accuracy is approximately 1%.

Calibration is not performed by means of external pressures but by electrical test signals (part of each of the input systems). In magnetic tape systems, all calibration is automatic; in oscillographic work, calibration is performed manually by means of internal simulated transducer output circuits.

The transducer should not be sensitive to vibration (with some larger units, vibration signals exceed the output due to the pressure fluctuations). Proper mounting reduces effects of vibration, both in location and mounting axis.

Flow

Flow measurement is accomplished best by turbine-type flow sensors which produce a signal whose frequency is directly proportional to volumetric flow. This frequency signal is then converted into a d-c analog voltage, which is recorded.

RECORDING FOR ENGINE TEST

The instrumentation used in gas-turbine engine tests includes pickups, direct-writing recorders and accessories, photographic recorders and accessories, and tape recorders and accessories. Recommended systems for each variable and each recording technique are presented.

If the frequency output from the flow sensor is too low, then the d-c recording will have considerable ripple and interference. To prevent this, a flow sensor must be selected which produces at least 200 cps at minimum flow. Special flow sensors have been designed which have ranges of approximately 200-2,000 cps for each measurement range. The response of the higher-frequency units is in the order of 20-30 flow variations per second. This has been found sufficient and corresponds to a rise time of 25 milliseconds. Over-all accuracy is about 2 to 3%.

Where flow of 200 pph (pounds per hour) or less must be measured, preamplifiers are used to provide a voltage signal sufficient for the operation of the frequency meters. This must be 0.2 volt or more. Calibration is performed by the insertion of fixed known frequencies that correspond to particular flow rates. Some equipment has built-in tuning forks for this purpose.

Co-axial cabling is used throughout the input system. If ripple or hash is still present, a complete check of the ground system must be made.

Speed

Speed measurement is made by high-frequency signals, as with flow. These signals, sufficient for the recording of good transients, are produced by modified engine tachometer generators which give approximately 2,000 cps output at full speed.

Another method of producing a high-frequency output proportional to speed is inserting a pickup adapter between the tachometer and engine pad. Also, a pulse pickup can be mounted near a suitable gear in the engine. One pulse, or cycle, is produced each time a gear tooth passes the pickup. The rise time, or response, is the same as for flow, although the inertia of rotors prevents speed changes much faster than a few cps.

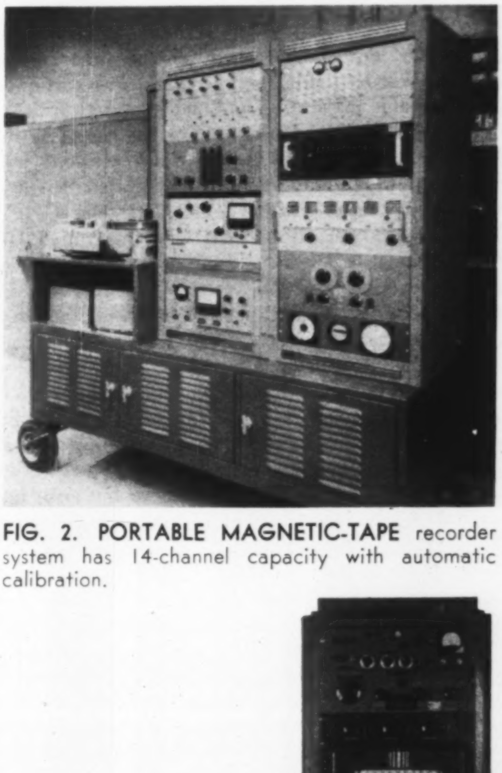


FIG. 2. PORTABLE MAGNETIC-TAPE recorder system has 14-channel capacity with automatic calibration.

FIG. 3. FUNCTION-PLOTTING system is x-y recorder.

When using magnetic pickups, the proper clearance between the pickup and the gear is important. Usually the pickup mounting is only $\frac{1}{8}$ turn (0.005″) from contact with the gear teeth. As in flow measurement, coaxial cable is used in all speed circuits. With magnetic-tape recorders a clipping circuit is used to prevent signal saturation of the amplifier input as it builds up in amplitude with engine speed. Conversion from pulses to analog voltage for tape recording is performed at the tape playback. Calibration is performed at the tape playback. Calibration is performed by means of fixed, known frequencies, internal or external to equipment. Preamplifiers usually are not required.

Vibration and Displacement

Vibration and displacement measurement can be recorded best by linking self-generating velocity pickups to suitable integrating and matching networks and high-speed recorders. Direct-writing recorders are sufficient for displacement because displacement level changes slowly. Photographic oscillographs are used for velocity measurement. The magnetic-tape recorder can be used to record velocity, with integration (for displacement) or spectrum analysis performed during tape playback. Velocity pickups are recommended because of their small size, ease of mounting, and self-generating characteristics.

The signal frequency range for small aircraft engine testing is from 100 to 400 cps. Accuracy of vibration displacement work is in the order of 3-5% with photographic oscillographs. The displacement indication meters used in test cells have corresponding accuracy limits for simple displacement, but error may reach 20% when the vibration becomes complex. Here, the photographic oscillograph or magnetic-tape recorder provides the only accurate measurement for analysis.

Calibration is performed by substituting known frequencies and voltages to simulate specific vibration conditions. The velocity signal is integrated to provide displacement reading at the pickup location and orientation. The recording represents a plot of instantaneous motion for each pickup, and when referred to speed is one of the few ways to analyze vibration in time history. When the pickups are used in high-temperature locations, such as turbine and exhaust areas, special forced-air-cooled jackets are required.

Torque and Thrust

Torque always has been a difficult dynamic measurement to make in high-speed rotating machinery. A hydraulic load-cell system, including a large dial indicator, is used in each test cell to indicate either thrust or torque. A pressure transducer connected in this system provides a dynamic signal for recording. The pressure measured is proportional to the torque or thrust. This system is adequate for dynamic thrust measurement, but it is not suitable in torque measurement because it includes the reaction of the dynamometer.

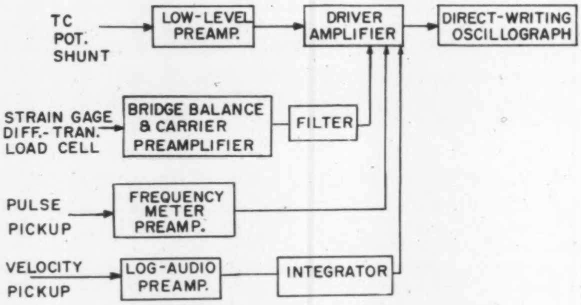


FIG. 4. ACCESSORIES for direct-writing oscillography.

A variable-permeance torque transducer placed between the engine and the dynamometer will give a satisfactory dynamic torque reading without contacting parts. However, this installation requires considerable investment and requires critical mechanical adaptation. An independent thrust measurement also can be made by the use of a strain-gage shaft with slip-ring output. Transient accuracies are in the order of 2-3%.

Calibration is accomplished by applying weights to simulate the force loads. In independent torque and thrust transducers, the calibration can be part of the measurement system and no external work is required.

Torque may have pulsations under vibration which can be reflected in the pick-up devices; this requires filters to smooth out the resulting hash. As filters cause the system to have a slower rise time or become sluggish, a compromise is required in each case and the filters adjusted accordingly.

Position

The ease of mounting, exciting and calibrating a potentiometer (voltage-dividing resistor) plus low cost, makes it first choice to measure position. With proper installation virtually every type of motion found in engine work can be measured by use of a "pot."

The serious limitation of a potentiometer system, however, is its inability to withstand rapid motions or high vibrations without excessive wear. When such conditions are present, either rotary or linear differential-transformers are used for position indication because they have no contacting parts. Accuracy of position measurement is within ±2% for most purposes.

When used with proper matching networks, differential transformers are connected in the same manner as pressure transducers. Occasionally the position of

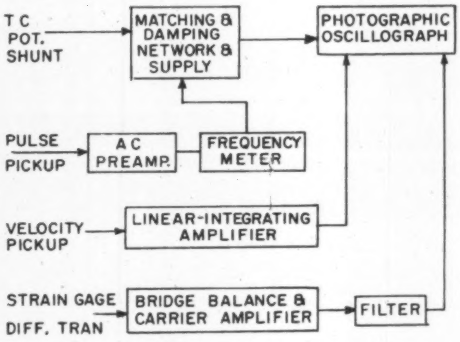

T C
POT.
SHUNT
MATCHING & DAMPING NETWORK & SUPPLY
PHOTOGRAPHIC OSCILLOGRAPH
PULSE PICKUP
A C PREAMP.
FREQUENCY METER
VELOCITY PICKUP
LINEAR-INTEGRATING AMPLIFIER
STRAIN GAGE
DIFF. TRAN
BRIDGE BALANCE & CARRIER AMPLIFIER
FILTER

FIG. 5. ACCESSORIES for photographic oscillography.

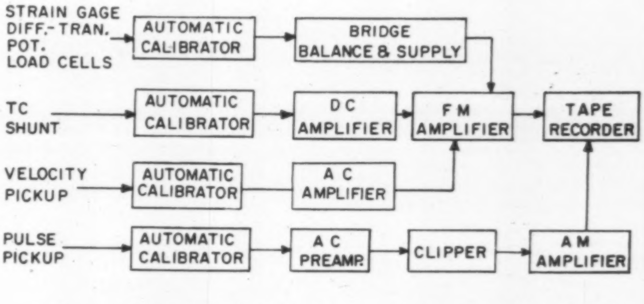

STRAIN GAGE
DIFF.-TRAN.
POT.
LOAD CELLS
AUTOMATIC CALIBRATOR
BRIDGE BALANCE & SUPPLY
TC
SHUNT
AUTOMATIC CALIBRATOR
D C AMPLIFIER
F M AMPLIFIER
TAPE RECORDER
VELOCITY PICKUP
AUTOMATIC CALIBRATOR
A C AMPLIFIER
PULSE PICKUP
AUTOMATIC CALIBRATOR
A C PREAMP.
CLIPPER
A M AMPLIFIER

FIG. 6. ACCESSORIES for tape recording. A direct-writing monitor (not shown) usually is used at output of the automatic calibrator.

a synchro transmitter (usually mounted on the engine for indication requirements) is recorded. In such instances a synchro repeater receiver is connected between the transmitter and the recording system.

Potentiometer systems are calibrated either by physical displacement or by substituting known calibration voltages to simulate given motions. Potentiometers must be selected carefully in order to avoid intermittent signals due to vibration or dirt on the contacting surfaces.

If an external battery is used for excitation, drift checks must be made often. For this reason electronic power supplies are preferred. In many cases the required voltage can be tapped from the input amplifier power supply by proper modifications.

Voltage

Fairly high voltages and currents often exist in test-cell work. It is imperative that inputs to measuring equipment do not produce momentary short circuits, especially during insertion or removal of input connectors.

Voltage is determined easily with dynamic measuring equipment. In most cases it is necessary to use a voltage-divider circuit to reduce the input voltage to an acceptable limit. In current measurements, a shunt is used which provides a voltage drop proportional to current. This voltage is usually low (in the order of 50 mv) and amplifiers must be used. The response is limited only by the recording system. Accuracy likewise depends on the recording system and is 2-3%, excluding divider or shunt error (1%). Starter voltage and current characteristics are measured often.

Current

In measurement of current it is necessary that the shunt be inserted in series with the grounded side of the line so that one point will be grounded or close to ground. Precaution must be taken if the input measurement circuit is required to operate ungrounded. In such situations it is possible to cause amplifier overload-distortion if the ratio of the voltage above ground to the voltage change being measured exceeds the common mode rejection of the amplifier, often as low as 20:1.

Calibration is performed simply by inserting accurately known voltages from sources either external to or built into the equipment for that purpose.

Oscillograph Circuitry

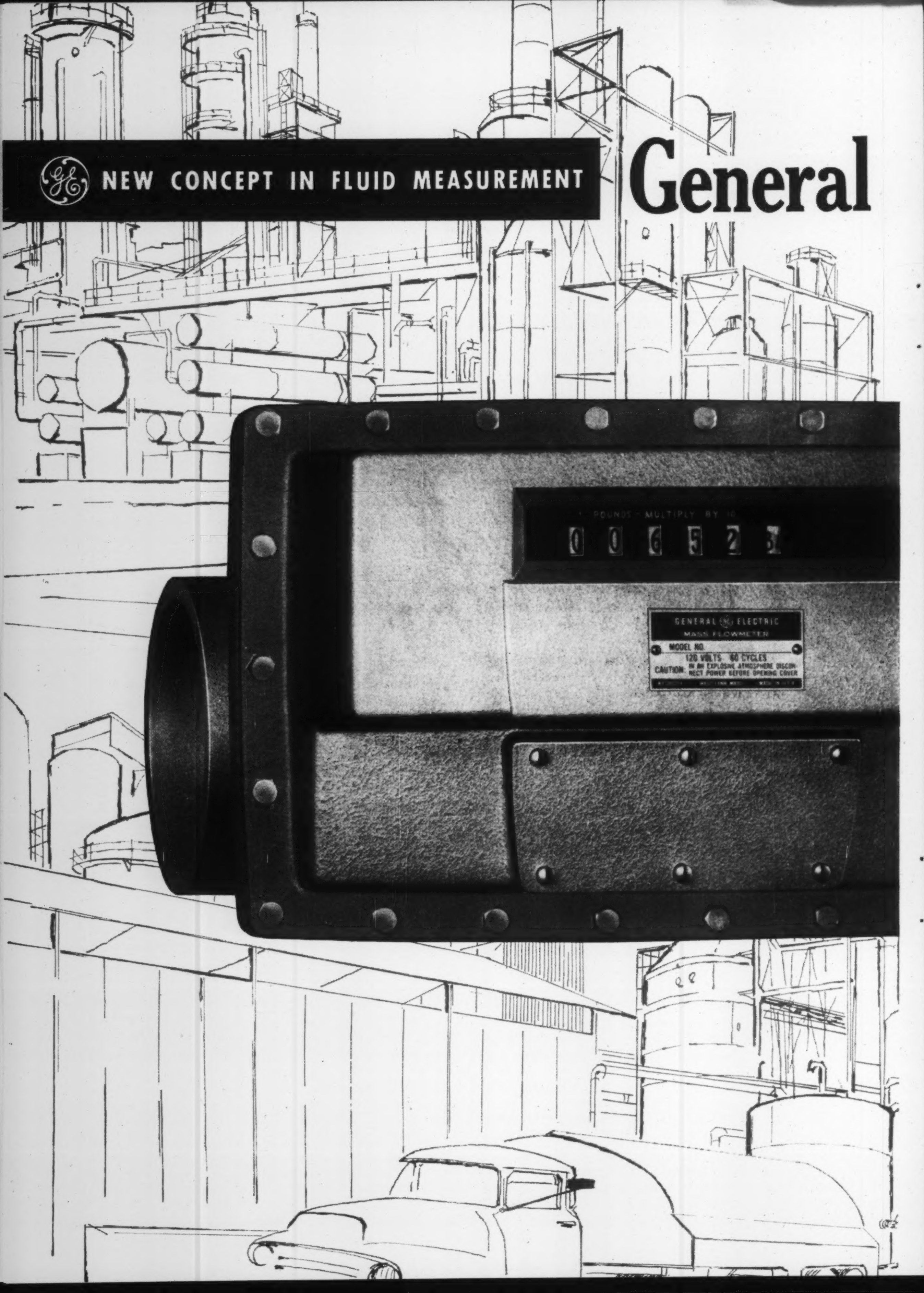
The light-beam galvanometer is essentially a current-measuring device. The recent development of high-performance galvanometers has approximately doubled former frequency ranges for direct recording, and opened a completely new field of low-output strain-gage applications.

Strain gages: One of the most common uses of the galvanometer is with resistance-type strain gages. Either two- or four-arm bridge circuits can be used. Where the bridge resistance equals required damping, no external damping resistors are required.

Potentiometers: Potentiometer outputs lend themselves to galvanometer recording requiring only the simplest of matching networks. Direct connection of the potentiometer to the galvanometer is possible. The matching network need include only sensitivity and damping resistors to provide optimum performance regardless of the potentiometer setting. Amplifiers may not be needed.

Thermocouples: The measuring and monitoring of temperature through the use of thermocouples is a simple yet highly accurate application of the galvanometer. Either series- or shunt-type damping resistors are employed, depending on the specific circuit requirements.

Amplification: Higher-frequency galvanometer information generally requires the use of amplification. Carrier, linear, and other forms of amplifiers provide high-frequency recording information. Typical output circuits can be the transformer, cathode-follower and phase-sensitive demodulator.

NEW CONCEPT IN FLUID MEASUREMENT
General
POUNDS - MULTIPLY BY 10
0 0 6 5 2 3
GENERAL ELECTRIC
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120 VOLTS 60 CYCLES
CAUTION: IN AN EXPLOSIVE ATMOSPHERE DISCONNECT POWER BEFORE OPENING COVER

Electric Gyro-Integrating True Mass Flowmeter

ACCURATELY MEASURES FLOW OF LIQUIDS, GASES AND LIQUEFIED GASES . . . DIRECTLY IN POUNDS

This new General Electric meter provides continuous local or remote totalization and registration of gas and liquid flow by weight within ±1 percent accuracy over wide variations in flow rate, density, pressure, temperature and viscosity.

PROCESS FLOW MEASUREMENT—Ideal for applications in the petroleum, chemical, and petro-chemical industries, the new mass flowmeter completely eliminates time-consuming orifice calculations and possible costly errors in correcting volumetric readings for fluid variables. It does away with the need for recalibration when process and flow conditions change, too. And it puts an end to supercompressibility problems.

What's more, the new flowmeter lets you make complete and accurate material balances easily because it operates on a mass measurement principle and gives you your answer *in pounds*. No more measuring liquids in gallons or barrels, gases in cubic feet, then making tedious conversions in order to equate the two. Measurement of both by weight allows direct comparison.

LIQUEFIED GAS MEASUREMENT—You can measure the weight of truck and tank car loading of your liquefied gas products easier and faster with General Electric's new mass flowmeter than with present volumetric-type meters or expensive and cumbersome scale installations. The meter registers the total loaded weight directly in pounds. Then, operating from a battery-inverter power supply, the flowmeter can be used right on your truck when unloading, for easy and accurate deliveries. And no precautions are necessary to protect the meter from high velocity caused by "flashing."

An outgrowth of General Electric research into mass flow measurement, this new meter has already been proved on such fluids as natural gas, ethylene, Freon, liquid carbon dioxide, naphtha and jet fuel.

For complete sales and service information, contact your nearby General Electric Apparatus Sales Office, or write for bulletin GEA-6925A, Section 599-02, General Electric Company, Schenectady 5, N. Y. On applications in the natural gas industry, contact Black, Sivalls and Bryson, Inc., Kansas City, Missouri.

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CIRCLE 67 ON READER-SERVICE CARD

Advanced

DEL F. KAHAN
Director of Engineering
Data Instruments Div.
Telecomputing Corp.

This new decommutation system recovers PAM and PDM signals accurately and requires no operator control. Possibility of human errors has been eliminated by reducing the need for system adjustment through the use of phase lock, chopper-stabilized circuitry and automatic frequency, gain, and zero-drift circuits. This is a recent addition to the White Sands Missile Range data-processing facility.

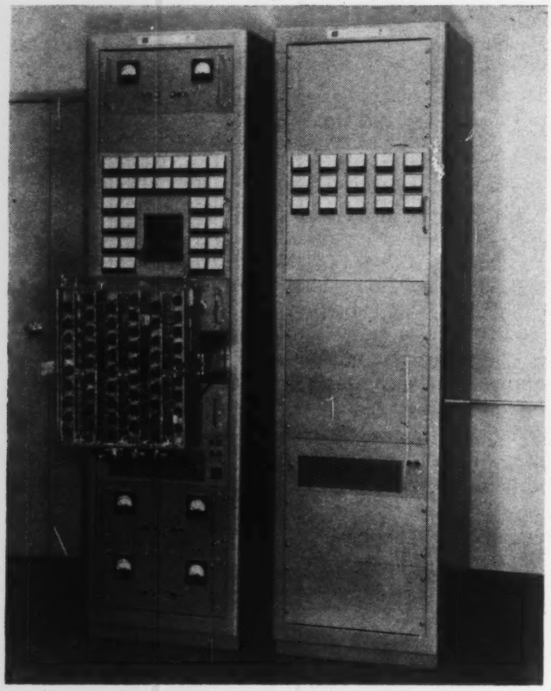

FIG. 1. COMPLETE 90-CHANNEL AUTOMATIC decommutation system.

IN TIME-MULTIPLEXED telemetry systems (Fig. 2) data from various transducers are sampled by a commutator, essentially a sampling switch. The commutator output (pulses whose amplitudes or duration are proportional to the transducer outputs at the time of sampling) is used to modulate the carrier or subcarrier that is transmitted to the ground station.

The ground-based receiver and discriminator demodulates the transmitted signal and applies the sequence of pulses to the decommutator. As each pulse represents a data sample taken at a distinct time, the decommutator must (1) reproduce the value of the original data signal and (2) separate each pulse so that it may be passed to the particular recorder or data-processing device handling the particular variable. The time sequence of the recovered pulses must exactly match that of the transmitted pulses.

Existing equipment relied on the action of each pulse in the sequence to establish its own synchronization. That is, as each pulse reached the decommutator it was expected to trigger a multivibrator to generate a pulse which would act as the time base for all further operations on the data pulse by the equipment. Unfortunately, this technique is subject to the various ills that can befall a data pulse—degradation of the leading edge of the pulse or insufficient amplitude can delay the multivibrator being triggered. Worse still, the multivibrator may fail to be triggered at all.

Recovery of the data value usually involves an integration of a portion of the pulse. Not only were the integrators failing to provide the data value to the required accuracy, but also they could not be reset to zero with sufficient speed to handle rapid pulse rates. The result was that values left over from one pulse might be super-imposed on the succeeding pulse with resulting serious crosstalk. Moreover, there were problems of drift in zero value and gain variations.

Phase-Lock Loop Synchronization

A phase-lock loop technique solved the problem of synchronizing the decommutator with the airborne signals. Rather than rely on each input data pulse to trigger its own synchronizing pulses in the decommutator, pulses are generated continuously by a free-

Decommutation System

running, voltage-controlled phantastron (Fig. 3). Frequency of the phantastron is controlled by a voltage varied in proportion to the difference in phase between the received pulses and the phantastron-generated pulses. Any deviation of the phantastron frequency from that of the airborne commutator results in a change of control voltage, bringing the phantastron back into synchronization with the transmitted pulses. This application of the phase-lock technique permits superior reconstruction of weak or faulty data pulses. The synchronization can be maintained over several seconds of complete signal drop out.

How the Decommutator Works

Fig. 4 shows the major sub-systems of the decommutation system and the action of these sub-systems on the telemetered signals. The *pulse selector* received the sequence of the pulses and generates a master pulse on receipt of the frame synchronizing pulse. This master pulse is used to reset the *counter* to zero. Subsequent pulses, generated by the pulse selector in synchronization with each received data pulse, advance the counter once for each pulse. These generated pulses, applied to the counter and patch panel, control all time-sensitive operation in the equipment.

The counter monitors the generated pulses and controls the sequence of actions within the system. A 5 x 18 shift register can control up to 90 data pulses and can be modified as required to 5 x 6, 5 x 9, 5 x 12, or 1 x 18 modes of operation. The counter will not reset on false master pulses such as would be caused by signal dropout in PDM modulation systems.

A *patch panel* permits various combinations of data pulses and output translators to be realized. The standard units have provisions for connecting any one output translator to as many as five data pulses, while the one data pulse can be used to drive up to five translators simultaneously.

Data pulses from the pulse selector are applied to the master integrator (Fig. 5). Operational-amplifier-type integrators integrate a slice of the data pulse (Fig. 6) to form a signal with amplitude proportional to the data pulse averaged over the interval of the slice. Use of this slicing technique results in a more accurate reproduction of the data value by eliminating

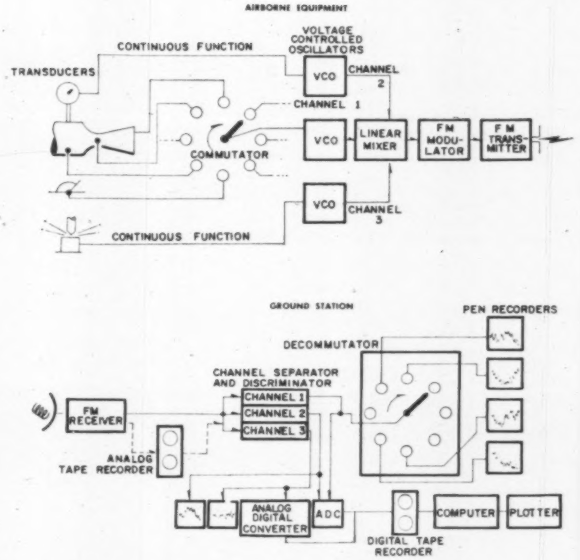
AIRBORNE EQUIPMENT
CONTINUOUS FUNCTION
VOLTAGE CONTROLLED OSCILLATORS
TRANSDUCERS
VCO
CHANNEL 2
CHANNEL 1
VCO
LINEAR MIXER
FM MODULATOR
FM TRANSMITTER
COMMUTATOR
VCO
CHANNEL 3
CONTINUOUS FUNCTION
GROUND STATION
PEN RECORDERS
DECOMMUTATOR
CHANNEL SEPARATOR AND DISCRIMINATOR
CHANNEL 1
CHANNEL 2
CHANNEL 3
FM RECEIVER
ANALOG TAPE RECORDER
ANALOG DIGITAL CONVERTER
ADC
COMPUTER
PLOTTER
DIGITAL TAPE RECORDER

FIG. 2. AIRBORNE AND GROUND station equipment for time-multiplexed data.

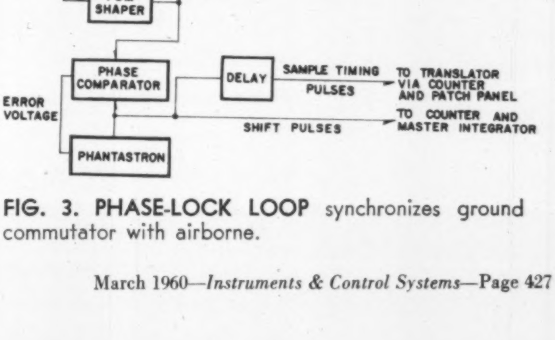
PAM SHAPER
PAM/PDM DATA
FRAME SYNC SEPARATOR
FRAME RESET PULSES
TO COUNTER
PDM SHAPER
PHASE COMPARATOR
DELAY
SAMPLE TIMING PULSES
TO TRANSLATOR VIA COUNTER AND PATCH PANEL
ERROR VOLTAGE
TO COUNTER AND MASTER INTEGRATOR
SHIFT PULSES
PHANTASTRON

FIG. 3. PHASE-LOCK LOOP synchronizes ground commutator with airborne.

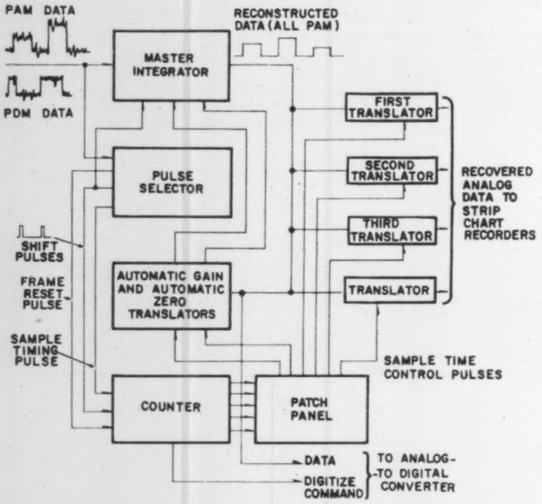
PAM DATA
PDM DATA
RECONSTRUCTED DATA (ALL PAM)
MASTER INTEGRATOR
PULSE SELECTOR
SHIFT PULSES
FRAME RESET PULSE
SAMPLE TIMING PULSE
AUTOMATIC GAIN AND AUTOMATIC ZERO TRANSLATORS
FIRST TRANSLATOR
SECOND TRANSLATOR
THIRD TRANSLATOR
TRANSLATOR
RECOVERED ANALOG DATA TO STRIP CHART RECORDERS
SAMPLE TIME CONTROL PULSES
COUNTER
PATCH PANEL
DATA
DIGITIZE COMMAND
TO ANALOG-TO DIGITAL CONVERTER

FIG. 4. DECOMMUTATION system PAM or PDM data can be reconstructed as sharp PAM signals and translated for strip-chart recorders.

ringing effects and decay at the leading and trailing edges of the data pulses, and by averaging out the effects of noise on the pulse. The master integrator uses three operational-amplifier-type integrators, operating sequentially to reduce crosstalk and to provide a superior response. The first pulse received by the master integrator is applied to one of the integrators, the second pulse to the second integrator, and the third pulse to the third integrator.

Sequencing of the integrators and timing of the slice is controlled by the synchronizing pulse from the pulse selector (Fig. 4). Outstanding feature of this time control is the variation of the slice width with the sampling frequency used in the airborne sampling system. As the number of samples per unit time decreases and pulse duration increases, more time can be devoted to the integration period. This advantageous use of available pulse time is made automatically by the decommutation system under the control of the pulse generated by the pulse selector.

Where pulse-duration modulation is used, the master integrator first generates a pulse whose amplitude is proportional to the duration of the transmitted data pulse. The integration process previously described then applies to this amplitude-modulated pulse. Conversion from the pulse-amplitude to pulse-duration modulation modes is by the actuation of a single switch mounted on the master integrator.

The outputs from the integrators are applied to an output amplifier which is connected to the three integrators by three switches operating sequentially in coordination with the status of the integrators. The output amplifier feeds the array of translators in parallel (Fig. 4). The particular translator (or translators) assigned to receive a particular data pulse is gated by the pulse from the pulse selector operating through the counter and patch panel. When gated to receive the data pulse, the translator (a chopper-stabilized operational amplifier and a storage capacitor) assumes the value of the pulse and retains this value until gated to receive the pulse in the next data frame, or the next data pulse in the same frame assigned to the translator.

The translator gives an output of plus or minus 15 volts, and it can deliver 10 milliamperes to a 1500-ohm load. The output impedance is less than 1.0 ohm from dc to 1000 cps. Translators with accuracies of 0.07% are incorporated.

Automatic zero level and gain compensation in the equipment can readjust zero shifts of ±10% with an error of less than ±0.1%. The automatic gain compensation can readjust for a ±0.1% full scale shift with an error of less than ±0.1%.

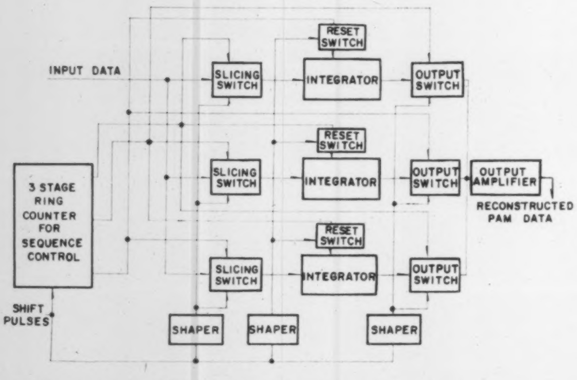
INPUT DATA
RESET SWITCH
SLICING SWITCH
INTEGRATOR
OUTPUT SWITCH
RESET SWITCH
SLICING SWITCH
INTEGRATOR
OUTPUT SWITCH
OUTPUT AMPLIFIER
RECONSTRUCTED PAM DATA
3 STAGE RING COUNTER FOR SEQUENCE CONTROL
RESET SWITCH
SLICING SWITCH
INTEGRATOR
OUTPUT SWITCH
SHIFT PULSES
SHAPER
SHAPER
SHAPER

FIG. 5. MASTER INTEGRATOR uses 3 operational-amplifier-type integrators.

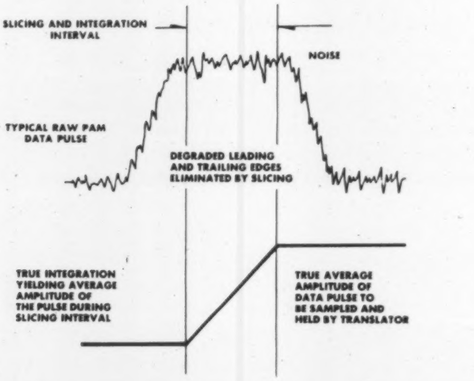
SLICING AND INTEGRATION INTERVAL
NOISE
TYPICAL RAW PAM DATA PULSE
DEGRADED LEADING AND TRAILING EDGES ELIMINATED BY SLICING
TRUE INTEGRATION YIELDING AVERAGE AMPLITUDE OF THE PULSE DURING SLICING INTERVAL
TRUE AVERAGE AMPLITUDE OF DATA PULSE TO BE SAMPLED AND HELD BY TRANSLATOR

FIG. 6. RECEIVED PULSE is sliced; leading and trailing edges are ignored. Integration during time slice represents true average amplitude.

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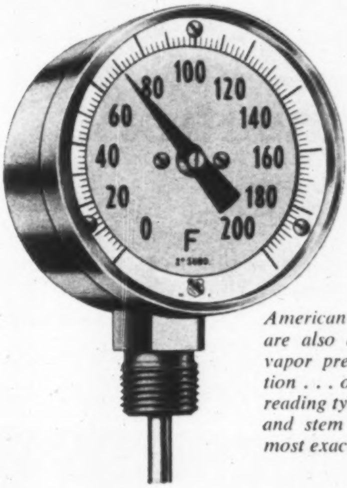

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CIRCLE 68 ON READER-SERVICE CARD

Wow and Flutter Compensation

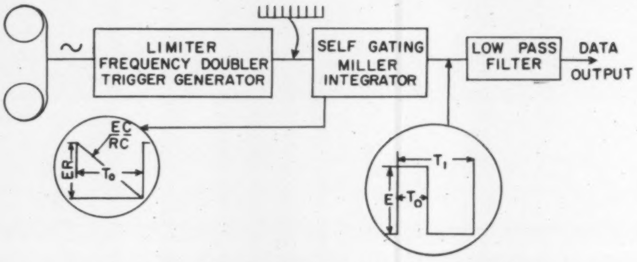

FIG. 1. FM DEMODULATION CHANNEL converts input FM signal into pulses, which trigger a Miller integrator. Rep rate of rectangular constant-width pulses determines output of low-pass filter, thus converting FM input into analog output. No compensation is shown here. In pulse-width compensation, the width of the pulse (T_0) is varied by the compensation channel.

Either subtraction or pulse-width compensation technique can be used to compensate for errors resulting from wow and flutter. Effects of each are described. Compensation of a multichannel recorder requires only addition of one or two special filters.

ROBERT L. PESHEL
Precision Instrument Co.

WOW AND FLUTTER normally is measured as follows: A signal of constant frequency is recorded on magnetic tape, either with high-frequency bias, or without bias and with a strong signal that saturates the tape. The reproduced signal is applied to a frequency demodulator either directly or through an equalized reproduce amplifier. The output of the FM demodulator is calibrated to read either peak-to-peak or rms noise. This output noise is termed *flutter*.

Starting with the assumptions that tape is perfect, that the circuitry and discriminator develop zero noise, and that tape-to-head contact is always intimate, then the noise signal from the discriminator measures only variations in the velocity of the tape across the record and reproduce heads. However, the speed characteristics of present tape-handling mechanisms are so good (0.1% RMS in the band from 1 to 300 cps is a standard specification on a typical instrumentation recorder for tape speeds of 7½″/sec and above), that tape and circuitry noise must be considered. The tape is not perfect: the tape contact with the record head is not intimate; and the noise of the circuit is not zero. Therefore, the word "flutter" will be used hereafter to denote only variations in the time base of the recovered intelligence, whatever the source.

It can be shown that an equally serious source of noise in an FM system is the amplitude fluctuation of the produced carrier signal. Amplitude disturbance resulting from tape imperfections, lack of perfect head-to-tape contact, and imperfect tape guiding, is immediately recognizable in a direct-recording system, and also appears as a second-order effect in an FM system. As reproduced flux is always differentiated to obtain the reproduced voltage, all points on the recovered waveform are affected by an amplitude disturbance.

Electronic Flutter Compensation

The need for flutter compensation usually is determined by the improvement obtained in using it. In some cases, such as the RDB narrow-band FM system, it may be mandatory. However, in a wide-band system compensation can be justified only if the improvement warrants the additional complexity.

If noise in an FM system is produced by tape-velocity variations, the effect is experienced by all data tracks of a multi-track tape. Therefore, a constant-frequency signal can be recorded on one track and the velocity variations of the tape measured by the frequency changes of this track. This information then can be used to compensate for the noise in the data tracks.

Two methods of theoretically compensating for the noise produced in an FM data track by the variations in tape velocity are (1) subtraction compensation and (2) pulse-area-control. The latter is most easily accomplished by control of pulse width.

Subtraction Compensation of an FM Data Channel

If all noise components detected in the reference channel were coherent (identical in the time domain) with those in the data channel, the noise output in the data channel could be eliminated completely by sub-

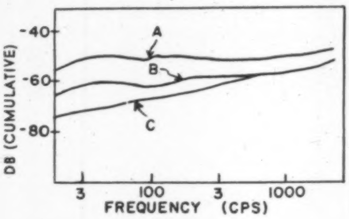

FIG. 2. COMPARISON OF SUBTRACTION (B) and pulse-width compensation (C) when data-channel carrier frequency is 1.4 times nominal-center frequency. A is without compensation. Ordinate is noise/signal ratio, peak-to-peak.

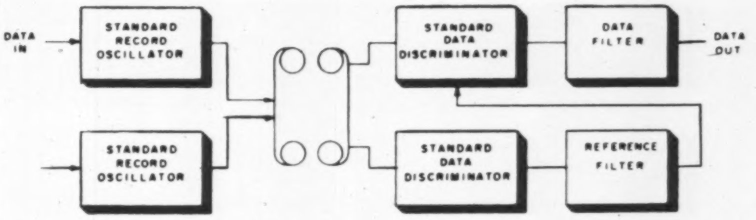
DATA IN
STANDARD RECORD OSCILLATOR
STANDARD RECORD OSCILLATOR
STANDARD DATA DISCRIMINATOR
STANDARD DATA DISCRIMINATOR
DATA FILTER
REFERENCE FILTER
DATA OUT

FIG. 3. BLOCK DIAGRAM of FM system with compensation.

traction. This subtraction can be accomplished with a minimum of filtering in the reference channel; delay distortion introduced is minor and the subtraction holds for all frequencies in the data bandwidth.

The effectiveness of subtraction compensation depends on the instantaneous relationship between the data-channel and reference-channel carrier frequencies. The net improvement obtained by this method must be specified in terms of the error in signal. In most subtraction systems a 1% speed variation produces 1% error signal. In this case, perfect noise cancellation for any carrier-frequency deviation is compromised for constant improvement at all noise frequencies.

Pulse-Width Compensation of an FM Data Channel

Pulse-width compensation is identical to subtraction up to the reference-channel output.

With pulse-width compensation, the output of the reference channel must be filtered to eliminate the reference carrier which would generate cross-modulation products in the data discriminator so that the width of the discriminator-generated data pulses (Fig. 1) will vary as a function of instantaneous reference-channel output. Because of the time delay in the reference filter, noise produced by tape-velocity changes at high rates is not eliminated completely.

Improved cancellation of low-frequency noise, irrespective of the data-to-reference-carrier relationship, is obtained only at the expense of degraded compensation at higher noise frequencies.

Comparison of Results Obtained with Subtraction and Pulse-Width Compensation

In order to determine whether pulse-width or subtraction compensation would be most desirable for an FM system, tests were made to compare the two systems using identical basic electronics (Fig. 2). Other tests investigated effect of carrier frequency change, putting reference and data signals on same and different tracks, effect of discriminator quieting characteristics, etc. Because of the large quantity of data taken, the tests were confined to a tape speed of 15 ips. The characteristics of the sytsem chosen were then measured at the other standard tape speeds.

The tests made comparing pulse-width and subtraction compensation indicate that at present the electronics is capable of correctly measuring the sum total of disturbance in the record-reproduce system. However, the major amount of wide-band noise that exists at the output of the FM system is a result of amplitude modulation coupled with the method of handling the data. Until this characteristic is improved (either by improved tape, mechanisms, or a different electronic approach to the problem) the output noise of an FM system will continue to be flutter-limited, where flutter must include not only tape velocity variations but also all other sources of noise that have contributed to the term.

Because of these basic noise considerations, there appears to be little difference between subtraction and pulse-width compensation as far as wide-band improvement characteristics are concerned. The pulse-width system is more efficient in eliminating low-frequency components irrespective of the reference-to-data-carrier frequency relationship.

User Considerations

Fig. 3 is a block diagram of the essential components for an FM recording system with compensation. Only one channel is shown. Each additional data channel would have the same elements, and would receive the output of the reference channel filter. The only item peculiar to a compensated system is one or two reference output filters (depending on the improvement desired in a multi-track system).

The FM record-reproduce system described can utilize pulse-width electronic compensation, if the user desires, simply by changing an output filter. The decision has been left to him because only he can determine, if properly informed, whether any improvement will be realized. If only low frequencies (up to 10% of full data bandwidth) are of interest, the signal-to-noise ratio can be improved with compensation. Little effect is noticed however, when wide-band analysis of the data is made.

In order to approach the maximum potential of an FM system, either with or without compensation, the sources of incoherent noise must be minimized. This implies that (1) the uniformity of the tape characteristics be high, (2) the method of handling the tape be as accurate as possible.

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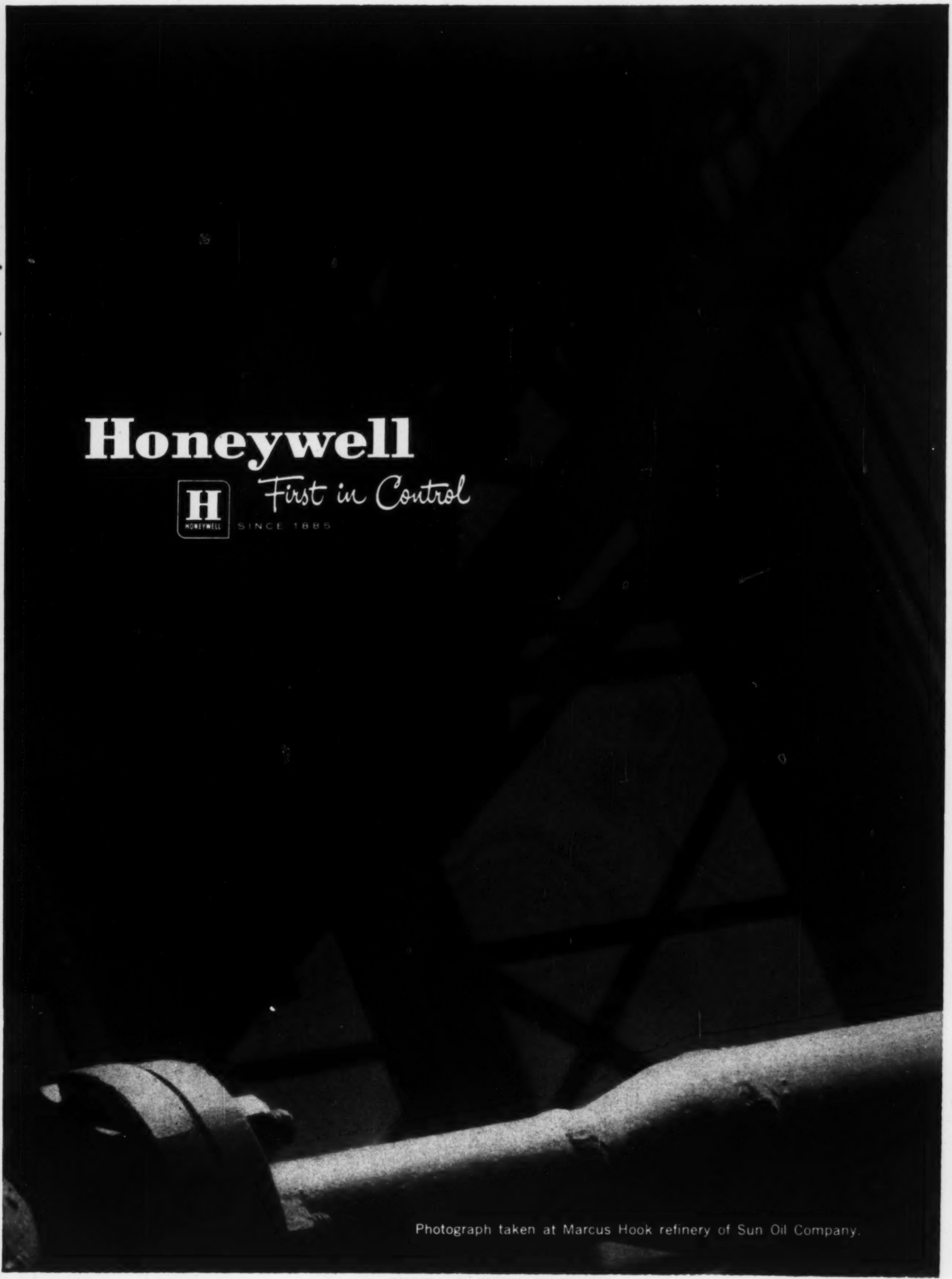
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TIME SCALE EXPANSION OF

A new magnetic-tape modulator head senses the flux from the tape rather than the rate-of-change of flux. As output voltage is independent of tape speed, applications include reduced-speed playback, data-reduction applications, transient analysis, bandwidth reduction and machine-tool control.

MARVIN E. ANDERSON
Armour Research Foundation

A MAGNETIC MODULATOR PLAYBACK HEAD has been developed which senses the recorded flux rather than the rate-of-change of flux. Thus recordings can be played back for analysis at any speed desired; high-frequency components can be played back at slow speed so that the highest recorded frequency component can be within the limited bandwidth of a pen recorder.

Fig. 1 shows the general configuration of one modulator head design. The recorded tape passes over the playback gap in the same manner in which it passed over the record-head gap. Signal flux flows through the structure and passes through two saturable strips at the bottom of the head, as shown. Two excitation coils are connected in such a way that the flux flows through the saturable elements but not through the playback gap, precluding the possibility of erasing the recording (Fig. 2). A high-frequency current is applied to the excitation windings of the head at a level sufficient to magnetically saturate the saturable strip. The output windings thus pick up a complex signal as a result of the variation of flux passing through the saturable strips.

Operation

Fig. 3 shows the transfer characteristics of the modulator head. It can be seen that if no bias were used, and the structure magnetically balanced, the output signal would be zero. When the excitation flux is biased off of the neutral position the output waveform would contain even harmonics, predominantly the second harmonic. Further, if this bias point varies as a function of the intelligence signal the amount of even harmonics will vary proportionately. The undesired even and odd harmonics must be filtered out and eliminated. This can be done simply by employing a single circuit tuned to the second harmonic of the excitation frequency as shown in the upper corner of Fig. 3. The output voltage ($V_{2nd\ harmonic}$) therefore takes the form of an amplitude-modulated carrier which requires demodulation to obtain the original recorded signal.

The bias and signal range labeled (A) in Fig. 3 represents the limits within which the bias and intelligence signal can vary. The corresponding modulated signal output also is shown. These limits insure that the modulation will not exceed 100%, and simple diode detection can be employed.

The dynamic range can be doubled and the distortion decreased if the bias and signal range labeled (B) are used. With this operation, a suppressed-carrier-type envelope is obtained which requires phase or synchronous detection.

Operation of the modulator head in the range of 10 kc to 400 kc is reasonable from the standpoint of tuned-circuit components and saturation problems (skin effects). Excitation currents on the order of 50 to 500 milliamperes can be used. Output voltage (the modulated signal) usually is greater than 20 millivolts and can be as great as several volts, depending on the playback gap size, which determines the intelligence flux level.

Fig. 4A shows a dual-channel head partially disassembled. The pole piece of this particular head is a modified standard non-laminated pole piece. The output coil contains approximately 100 turns and the excitation coils approximately eight turns each (wound

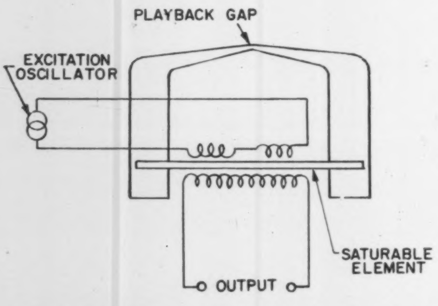

FIG. 1. MAGNETIC modulator head of one design.

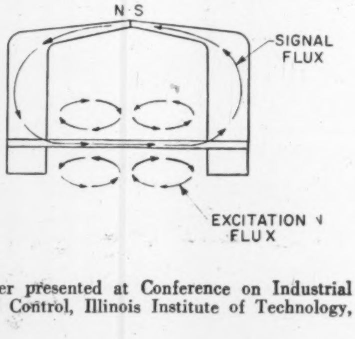

FIG. 2. FLUX path in head.

Abstracts from paper presented at Conference on Industrial Instrumentation and Control, Illinois Institute of Technology, April, 1959.

MAGNETIC-TAPE RECORDS

in opposition). Fig. 4B shows the head assembled. Each track is 0.048″ wide and spaced 0.140″ on centers for use on ¼″ tape.

The upper head and gap configuration is similar to the pole piece and gap geometry on an ordinary record-playback velocity-type head so the modulator head has the same wavelength limitations—that is, the output approaches zero as the recorded wavelength approaches the playback gap length; the output again decreases to zero as the wavelength increases to dimensions beyond the head-to-media contact length. The output does not vary as a function of speed, however, so that the playback frequencies can approach zero with no deterioration in the signal-to-noise ratio.

Applications

Many applications exist in data reduction problems.

One application called for a playback system which could be employed in the analysis of transient recordings. The transients consisted of frequencies in the range from 400 cps to 100 kc and were recorded at 60 inches per second, giving recorded wavelengths ranging from 0.15″ to 0.0006″. On playback the tape speed was greatly reduced and the system was required to read the recordings at tape speeds down to and including zero so that the transient signals could be rerecorded with a pen recorder. The same modulator playback system was employed to reduce the frequency bandwidth of test data recorded in the field so that it could be transmitted over conventional telephone lines to the central laboratory for analysis.

This test data was in the form of FM subcarrier signals ranging from approximately 400 cps to 100 kc. Playback was accomplished with the tape reduced from 60 ips on record to 3.75 ips on playback. The highest frequency signal which was used for timing (100 kc) was therefore reduced to 6250 cps. This bandwidth reduction made it possible to transmit the composite recording over ordinary telephone lines.

The magnetic modulator playback head also has been put to use in a machine control problem. Briefly the system was required to control the stitching mechanism of a cobble machine in the textile industry. An artist's sketch of a repetitive pattern was placed under a grid and a pattern recording was manually coded onto a drum. This coded pattern information was then employed in the system shown in Fig. 5.

Acknowledgement

This work was done under the sponsorship of C. H. Masland & Sons, Sandia Corporation and ARF. Thanks are due J. N. Van Scoyoc and R. W. Bull for their guidance and advice.

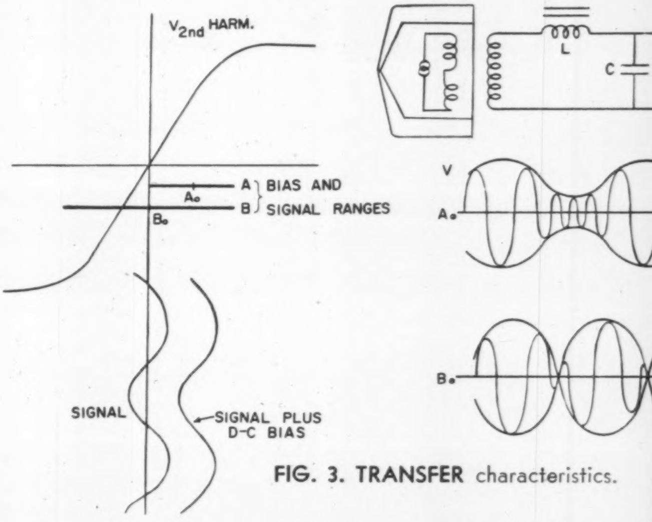

FIG. 3. TRANSFER characteristics.

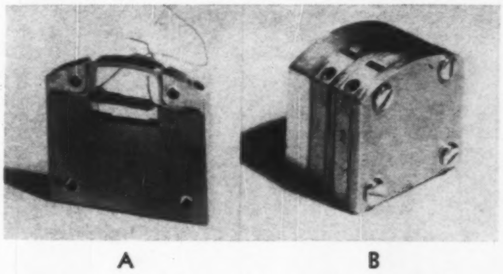

FIG. 4. ONE CHANNEL (A); assembled dual-channel modulator head (B).

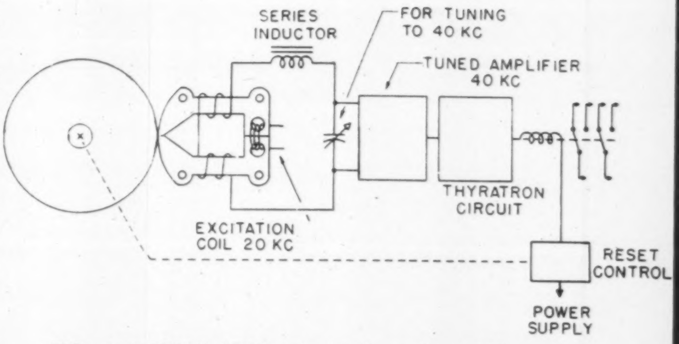

FIG. 5. MODULATOR playback equipment for machine control problem. As drum turns, coded data controls latching coils, which control amount of yarn stitched and pile height.

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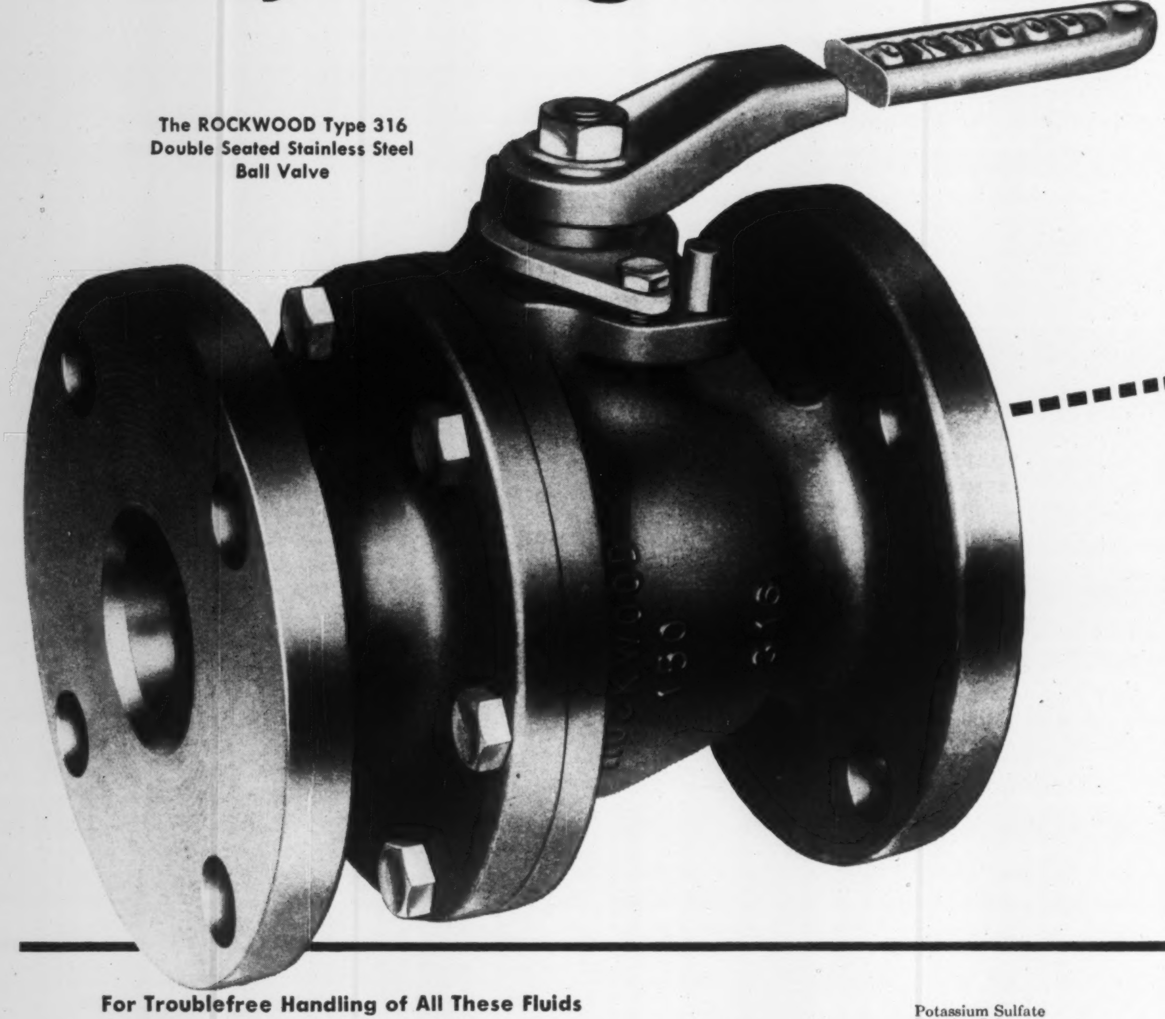

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Mine Waters
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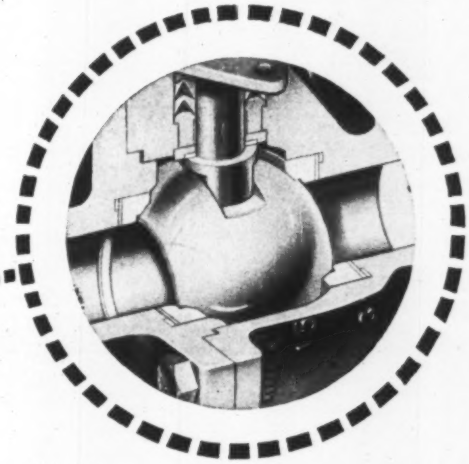

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- 600 psi with screwed ends
- 150 lb. flanged to M.S.S. with standard 150 lb. face to face dimensions. Also available with 150 A.S.A.
- 300 lb. flanged to A.S.A. with standard 300 lb. face to face dimensions.

*DuPont Reg. Teflon seals include seats and adjustable chevron stem packing. Also available with nylon or synthetic rubber seals.

****Patent Pending**

ROCKWOOD
BALL VALVES

FULL, ROUND FLOW

ROCKWOOD SPRINKLER COMPANY
A Division of the Gamewell Company
261 Harlow Street, Worcester 5, Massachusetts

Please send full details on the new Type 316 Double Seated Stainless Steel Ball Valve.

Name. . . . . *Title*. . . . .

Company. . . . .

City. . . . . *Zone*. . . . . *State*. . . . .

. . . .

CIRCLE 70 ON READER-SERVICE CARD

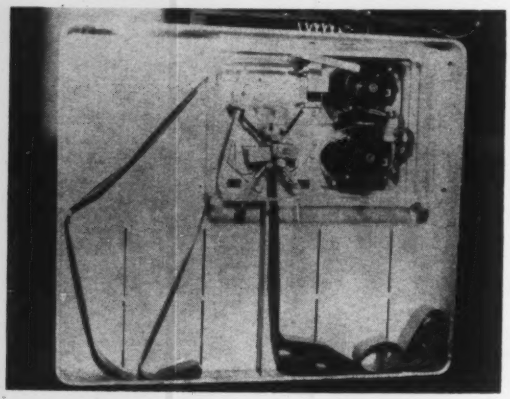


FIG. 1. Magnetic-tape delay line.

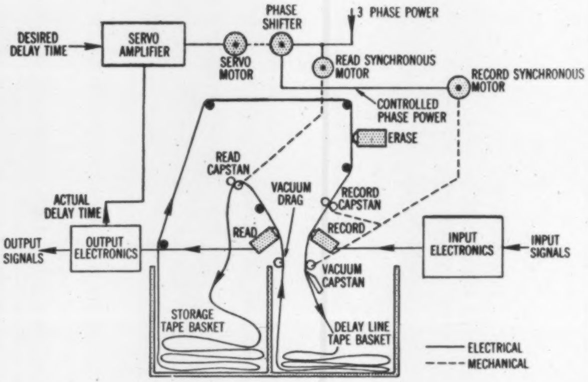

DESIRED DELAY TIME
SERVO AMPLIFIER
SERVO MOTOR
PHASE SHIFTER
3 PHASE POWER
READ SYNCHRONOUS MOTOR
RECORD SYNCHRONOUS MOTOR
CONTROLLED PHASE POWER
ERASE
READ CAPSTAN
VACUUM DRAG
RECORD CAPSTAN
ACTUAL DELAY TIME
READ
RECORD
OUTPUT SIGNALS
OUTPUT ELECTRONICS
INPUT ELECTRONICS
INPUT SIGNALS
VACUUM CAPSTAN
STORAGE TAPE BASKET
DELAY LINE TAPE BASKET
ELECTRICAL
MECHANICAL

FIG. 2. Elements of system.

Servo-Controlled Magnetic-Tape

LAWRENCE J. KAMM, Convair-San Diego

SERVO CONTROLLED Magnetic Tape Delay Line (Fig. 1) is an analog computer element. It receives continuous analog signals, stores them on magnetic tape, and emits the same signals a short time later. The time delay may be varied from 6 milliseconds to 10 seconds.

This delay is servo controlled from a clock channel on the tape and can be varied continuously while the machine is running. The delay is accomplished by modifying the servo reference input. The Magnetic Tape Delay Line provides 10 signal channels in addition to the clock channel.

The Delay Line is used in conjunction with analog computers for auto-correlation problems and for simulation of physical systems in which time delays occur. In order to prevent cumulative degradation of signals which pass through the machine many times, the analog signals are converted to digital form within the equipment.

The elements of the machine are shown in Fig. 2. These include an *Endless Tape Loop;* a *Record Head* which puts the input signals on the tape; a *Read Head,* which takes the signals off the tape; and an *Erase Head,* which clears the tape for re-recording. The tape moves at constant speed around the loop. The Delay Line proper is the length of tape between the Record and the Read heads. This length may be changed by varying the speed of the tape past the Record Head, while holding the speed at the Read Head. The total length of tape is 80 feet for the 10-second maximum delay desired. When the line is adjusted to less than maximum length, the surplus is kept in a tape storage container through which the loop runs.

To produce the desired minimum time delay of 6 milliseconds at a tape speed of approximately 100 inches per second, the length of tape between Record and Read heads must be only ½ inch. This is less than the space which the heads themselves take up and leaves no room for a capstan and tape loop. Therefore, the heads are tipped toward each other so that they are almost face to face and can be bridged by a closely bent loop of tape. This loop can be lengthened without limit.

The Read capstan is located in the conventional position following the Read head, but the Record capstan is placed before the Record head and pays out the tape at the desired rate. When the tape loop is lengthened, the Vacuum capstan, "V", comes into action. It is coupled to the Record capstan but uses vacuum instead of a pinch roll to grip the tape. The vacuum drag "X" is a non-rotating guide pin having a vacuum slit which pulls on the tape to maintain tension on the Read head.

Specifications

Minimum Delay—0.006 sec (½" of tape)
Maximum Delay—10 sec (78' of tape)
Maximum Rate of Change of Delay—6 seconds per minute
Tape Speed—94"/second
Number of Channels—11 data channels plus 3 clock channels
Tape Width—1¾"
Type of Tape—Mylar, 0.002" thick, M.M.M. No. 108 or 148
Power Supply—208 volts, 3 phase, 60 cycles
Motor—Hysteresis Synchronous, 3600 rpm
Type of Heads—Clevite-Brush, 1500 series
Vacuum Pumps—Leiman, self contained

Delay Line

Delay Control Servo

The Read capstan is driven at fixed speed by a hysteresis synchronous motor energized directly from the 60-cycle line. The Record capstan is driven by a similar motor, but a phase shifter is interposed between motor and line to vary the capstan speed. The *Delay Control Servo* includes the clock portion of the input and output electronics which measures actual delay, the amplifier which compares actual delay with desired delay, and the servo motor and phase shifter which injects a differential rotation into the record capstan to vary the actual delay.

The Vacuum capstan is a hollow tube which is perforated along the length in contact with the tape and is driven by the same belt as the record capstan. A stationary valve plug inside the tube is provided which closes off all the perforations except along a 90° arc. To guide the tape and prevent any possible over-drag, a blunt peeling blade is mounted just beyond the pneumatic release point.

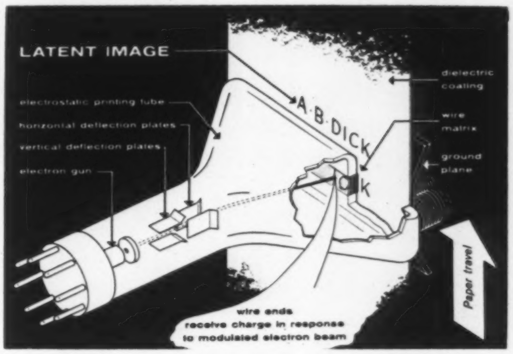
The tape guide pins are cylindrical pins with two guide flanges. Jamming of tape falling from the Read capstan output into the storage basket was eliminated by providing a runout surface exactly in line with the outcoming tape, adequate room for zig-zag waves to settle out, and air vent slots in one wall of the basket.

Videograph Process

KEY element of the Videograph Process (A. B. Dick Co.) is a special cathode-ray tube designated EPT—an electrostatic printing tube (Fig. 1). Printing rate is 20,000 characters per second. Reproduction can be from hard copy, microfilm, tape, halftone prints, photos, maps or video camera.

The electron gun directs an electron beam toward a glass faceplate. Spaced, small-diameter wires are fused into this faceplate. The inner ends of the wires face the electron gun and the outer ends are exposed to the atmosphere, thus forming a series of spaced and insulated conductors extending from the inside to the outside of the tube. A single row of 0.001" stainless-steel wires spaced on 0.004" centers for a density of 250 wires per inch is being used for facsimile reproduction.

The first step of the printing process is to create an electrostatic image on the printing medium—usually paper. The paper is supported against the outer surface of the face plate of the EPT and is backed up by an electrically grounded plate or roller. When the electron beam strikes the inner ends of the wires electrons are conducted through the wall and deposited on the paper surface as a negative charge pattern.


LATENT IMAGE
A·B·DICK
electrostatic printing tube
horizontal deflection plates
vertical deflection plates
electron gun
dielectric coating
wire matrix
ground plane
Paper travel
wire ends receive charge in response to modulated electron beam

The direction of the electron beam within the EPT can be controlled conventionally by pairs of horizontal and vertical deflection plates, or by electromagnetic coils around the neck of the tube. Voltages applied to either the plates or coils deflect the beam in a prescribed path against the inner surface of the faceplate. While the beam sweeps the exposed inner ends of the wire matrix to form a raster the beam is amplitude modulated at high rates by applying voltages to the grid of the electron gun. Electrical charges are placed on the wires in a pattern and are deposited on the printing medium to form a latent electrostatic image.

In the final step the electrostatic latent image is developed into a visual image and "fixed" to provide permanency. A mixture comprising a carrier and a toner powder is applied to the surface of the paper on which the electrostatic latent image has been created. The toner is a pigmented thermoplastic resin powder which, when heated, forms permanent black images in the shape of the charge pattern.

PARTLOW
CONTROLS

Send for free brochure. PARTLOW CONTROLS . . . A handy, condensed catalog of the complete line of Partlow temperature controls and allied equipment for industrial heating and refrigeration.

FAST, ON-TARGET DELIVERIES . . .

Another reason why more firms than ever are using Partlow Temperature Controls

Much of Partlow's business involves special controls to solve special application problems.

No matter how off-standard the control, however, the odds are better than 99-to-1 that the Partlow you order will be delivered well within our regular 3-to-4 week schedule. During the past 12 months — the busiest in our 40-year history — 99% of all the controls we produced went out *on time*, or ahead of it!

Of course, prompt, dependable delivery is only one reason for the mushrooming demand for Partlow products. Here are a few others:

Mercury Actuation, which lets the Partlow function without an outside power source or temperamental electronic amplification . . .

Unmatched Design Simplicity, which enables the Partlow to withstand even extreme conditions of shock, vibration, corrosion, dust and moisture, without loss of accuracy or sensitivity . . .

Interchangeability of Elements, which makes it possible for any Partlow to be serviced at the job site, virtually eliminating "down time."

Partlow makes a complete line of electric, mechanical and pneumatic controls (recording, indicating and non-indicating) for temperatures up to 1100°F. Whatever your application problem, Partlow makes an instrument to handle it efficiently, economically, *precisely*. Write for details: The Partlow Corp., New Hartford, N. Y., Dept. IA-360.

PARTLOW

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TEMPERATURE CONTROLS

World Export:
Ad. Auriema, Inc., 85 Broad Street, New York 4, N. Y.

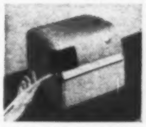
CIRCLE 71 ON READER-SERVICE CARD

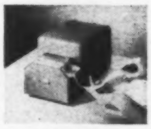
Teletype machines help cut costly paperwork

A Teletype machine equipped with a simple sprocket-feed mechanism can handle multi-carbon forms as readily as the more familiar plain paper on which messages are transmitted. Thus distances can be bridged not only with information, but with information that is preprocessed, ready to go to work.

Teletype printers handle a wide variety of multi-copy forms. Moreover, the usefulness of this technique can be further extended with Teletype tape punching and reading equipment—which can capture, store and utilize repetitive data to further mechanize paperwork procedures.

For more information about Teletype Model 28 equipment, please write to Teletype Corporation, Dept. 27C, 4100 Fullerton Ave., Chicago 39, Illinois.


Typing Tape Punch


Tape Reader

Send-Receive Page Printer

Automatic Send-Receive Set

TELETYPE®
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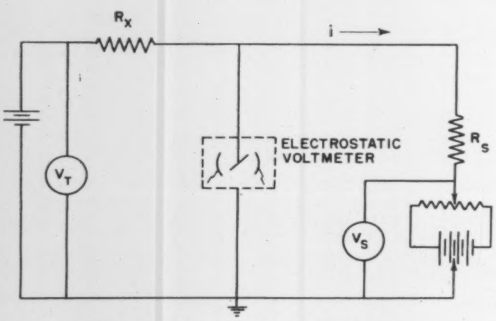
SUBSIDIARY OF *Western Electric Company* INC.

CIRCLE 72 ON READER-SERVICE CARD

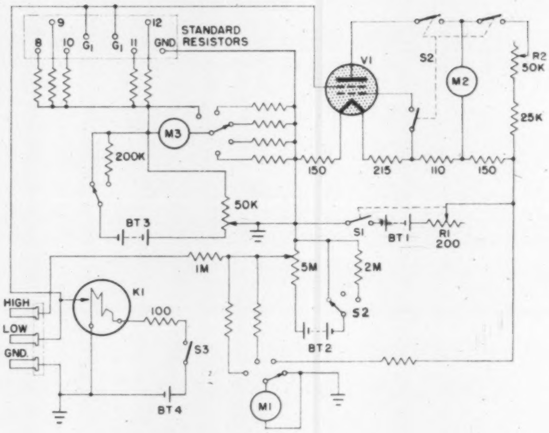
ELECTRONIC CIRCUITRY

CHARLES F. KEZER and MILTON H. ARONSON

SLIDEBACK ELECTROMETER FOR MEASURING HIGH RESISTANCE



V_T = TEST VOLTAGE
V_S = SLIDE-BACK VOLTAGE
i = CURRENT
R_X = RESISTANCE OF COMPONENT UNDER TEST
R_S = STANDARD RESISTANCE



Measurement of high resistance, such as insulation, is of growing importance. A series-resistance method has been discussed by Norman and is an outgrowth of a series-capacitance method employed by Race. Their instruments employ a high-impedance null detector and a slideback compensating voltage.

The series-resistance method is shown in Fig. A, which is a simplified form of Norman's circuit. Test voltage V_T, causes a current (i) to flow through the circuit in which R_X is the resistance under test and R_S is a known standard resistance. The slideback voltage V_S must equal $-iR_S$ for the null detector to read zero. For example, when $R_S = R_X$, then $V_S = V_T$. This method of measurement has several advantages: (1) the test voltage is the exact voltage which appears across the unknown, (2) the slideback voltage can be read on a high-accuracy D'Arsonval-type indicator, and (3) with guard-ring techniques the guard and guarded electrodes are at the same potential at the time of measurement.

Fig. B is a schematic drawing of the instrument described.

Electrometer tube V1, is a 5800/VX41A subminiature electrometer tetrode. This tube has extremely high leakage resistance (greater than 10^{15} ohms) between the control grid and the other electrodes, and extremely low grid current (nominally 3×10^{-15} ampere).

Indicators—The instrument contains three indicators. The slideback-voltage voltmeter (M3) measures the magnitude of the slideback voltage. This meter has ranges of 1, 5, 10, and 50 volts full scale, plus a "meter-short" position for zeroing. It has a mirrored scale, 10,000-ohm-per-volt 1-percent movement, and a resistance of 1000 ohms.

The second indicator (M2) is a 15-0-15-microampere mirrored-scale galvanometer for null detection. R2 is for balancing plate current and bucking current when the control grid of V1 is grounded.

The third indicator (M1), identical to that of M3, has ranges of 100 and 500 volts full scale. This "test-voltage voltmeter" measures the magnitude of the test voltage and has a "Fil. 10" position for establishing the proper bias voltage, accelerator voltage, and plate voltage for the tube.

Grid Grounding Switch—Switch 3 (bottom left) will either ground or unground the input of the electrometer. It controls the current applied to a high-resistance thermally operated switch (K1). The resistance of this switch when open is a minimum of 10^{15} ohms.

Standard Resistors and Shield—The standard resistors are a carbon-film type, vacuum sealed in glass envelopes, and especially treated for stability under high humidity conditions. The values are approximately 10^8, 10^9, 10^{10}, 10^{11}, and 10^{12} ohms. These resistors were measured to an accuracy of 0.2% by the National Bureau of Standards. Experience with this type of resistor has shown that fluctuations with time may be as great as 1.0%.

The standard resistors are mounted on a polytetrafluoroethylene block containing banana jacks which allow easy selection and connection to the gird circuit of the desired standard resistor.

Using the test-voltage switch and test-voltage adjustment knob, and with the test-voltage meter on the proper range, the desired test voltage is set. A standard resistor of approximately one-hundredth the value of the resistor being measured is inserted into the circuit with a jumper from G_1 to the desired resistor. The unknown resistor is connected between the high and low terminals. With the grid still shorted to ground, the test voltage is switched on, the grid is ungrounded so that a voltage appears cross the standard resistor, and a slideback potential is introduced such that the null indicator is just returned to zero.

The resistance of the unknown resistor is calculated from:

$$R_X = R_S\ (V_T/V_S)$$

where R_X = resistance of resistor under test; V_T = test voltage; V_S = slideback voltage; R_S = resistance of standard resistor. Accuracy of ±2% is common.

The null indicator can be calibrated in percent from nominal, and used for sorting. It also can be used for measuring leakage resistance of capacitors.

Supplies—The voltages for the electrometer tube are supplied by six 1½-volt batteries (BT1) and dropping resistors. The test voltage (10 to 500 volts) is supplied by two 300-volt batteries (BT2) and a potentiometer. The two batteries can be connected in series or in parallel. A safety resistor of 1 megohm is included between the test-voltage supply and the high-voltage terminal to eliminate shock to the operator if the terminal is accidentally touched and to protect the supply batteries in event of accidental shorting or a breakdown of the item under test. This safety resistor is small compared to any resistance being measured in the circuit and can be neglected in the calculations.

The slideback voltage is supplied by a 30-volt battery (BT3) and a potentiometer arrangement.

Source: N. J. Doctor and P. J. Franklin, "Slideback Electrometer," *Instruments & Automation,* June, 1956.

PORTABLE CURRENT PATH VERIFIER IDENTIFIES WIRES IN CABLE BUNDLES

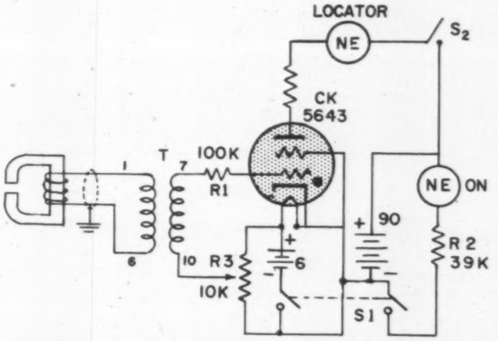
This "Portable Current Path Verifier" was developed to correlate connector pins and connecting wires in wire bundles having potted connectors at each end.

The sensing device consists of a hinged iron core (clamp-on ammeter type) upon which a multi-turn coil has been wound. This was a Triplett Model 10 clamp-on adapter with range switch and resistors removed. When a wire is being checked for connection between two pins, making and breaking the continuity checking circuit will induce a voltage in the coil—if the core is on the proper wire. The coil is transformer coupled to the grid of a miniature thyraton tube. The tube is biased so that the induced voltage will ionize the tube and initiate conduction. A neon glow lamp (Type NE-2) indicates the conduction state of the tube. The tube will continue to conduct until the plate circuit is opened; thus, a go/no-go indication is obtained.

S1 is on-off switch for instrument; S2 is spring-return normally-closed switch that turns locator light off by breaking plate circuit.

Transformer shown is Triad HS-3.

R3 (10K 2-watt pot) is adjusted to bias the tube so the continuity tester used (multimeter or flash lite batteries and lite) will initiate conduction on "make" or break" of a continuous circuit. R1 and R2 are ¼-watt resistors.

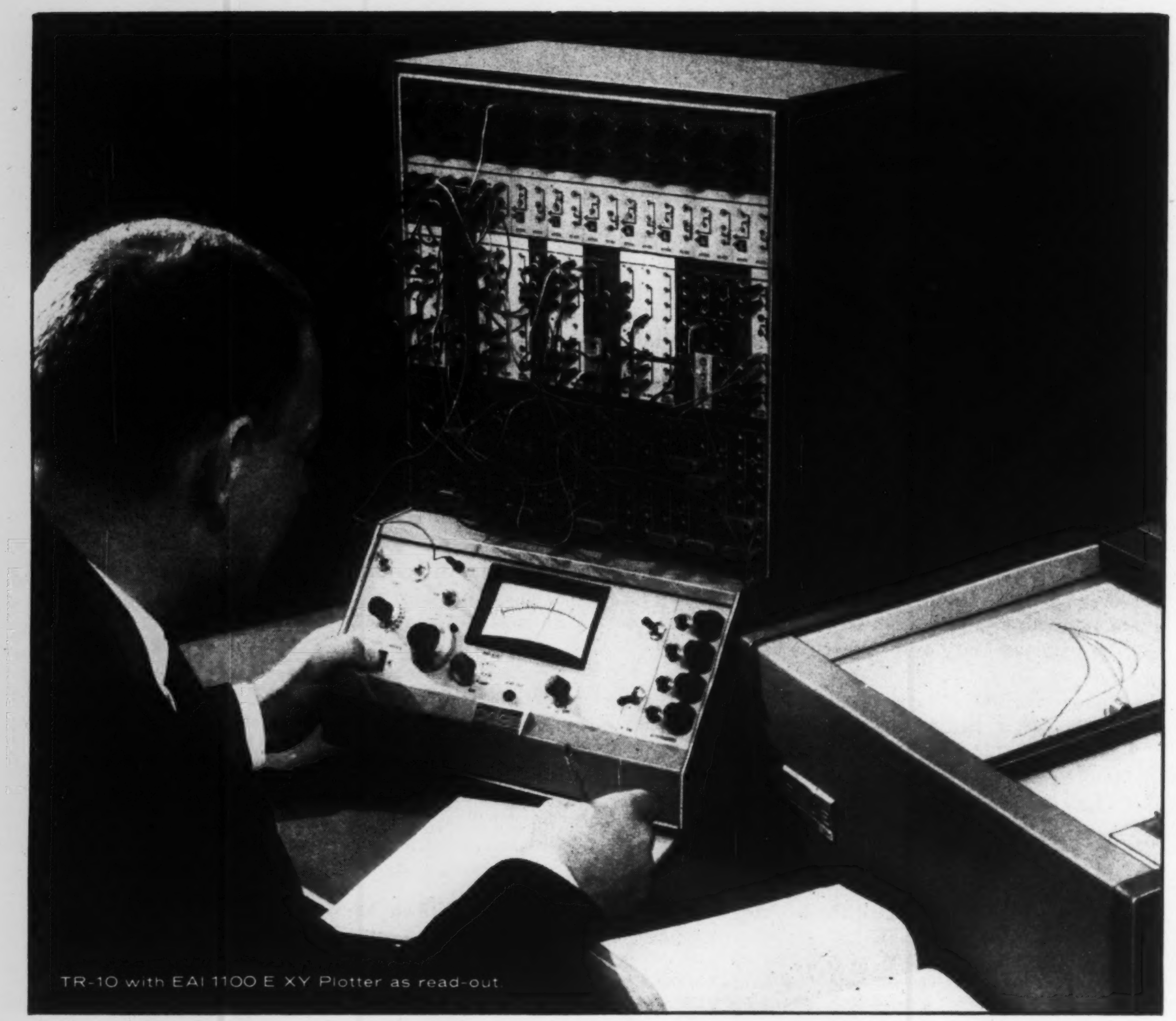


The thyraton tube used is a CK5643, which has a filament requirement of 15 ma at 6.3 volts. This low power requirement enables the device to be battery operated and portable.

A Supply: 6.3 volts at 15 ma for filament (Burgess N60 or equiv.)

B Supply: 90 volts at 1.5 ma max (Burgess F4BP or equiv.)

Source: Jack Wecker, Boeing Airplane Co., Wichita, Kansas; also Oct. issue of *Boeing Magazine,* Wichita 1, Kansas.



TR-10 with EAI 1100 E XY Plotter as read-out

THE *FIRST* ALL TRANSISTORIZED ANALOG COMPUTER

—basic model less than $4000

PACE® TR-10 Eliminates Drudgery—Gives New Insight Into Engineering Problems

This compact unit, 15″ x 16″ by 24″ high, is powered by 115 volts AC and can provide day-in day-out instant solution of your most vexing engineering problems. Even if you have never seen a computer before, you can learn to operate the TR-10 as easily as you learned to use a slide rule.

Simply turn a dial to feed in design parameters, and the computer provides an instant by instant, dynamic picture of the effect of each change. You can study the inter-related effects of heat, pressure, flow, vibration, torque or any variable, and visually compare one with the other. Engineering data comes alive – insight into how new designs will work is obtained easier, faster.

Because of its minimum size and low price, the TR-10 can become your own personal analog computer. You gain first-hand experience with the power of analog techniques, and convert more of your time to *creative engineering.* New ideas that were too costly to try before are now practical. You can design virtually to perfection and have a permanent, visual record of performance before building pilot models or prototypes. As a result, "cut and try" expense is reduced.

The same quality workmanship and design that has made Electronic Associates the world's leading producer of precision general purpose analog computers will be found in this new unit. Accuracy to ±.1 per cent. Modular construction allows you to select varying quantities of the following computing functions: summation, integration, multiplication or division, function generation, parameter adjustment, logical comparison.

For complete engineering data, write for Bulletin TR-10-F.

EAI

ELECTRONIC ASSOCIATES, INC.
Long Branch, New Jersey

CIRCLE 73 ON READER-SERVICE CARD

The SIMULATION COUNCIL Newsletter

John H. McLeod Jr., EDITOR

Suzette McLeod, SECRETARY

8484 La Jolla Shores Drive,
La Jolla, California

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Stan Rogers, Convair, San Diego, Calif.; Chairman, Board of Directors

Your Newsletter

Your *Newsletter* is now more than seven years old.

Those of you who have been with us through these years know that its character has changed randomly from issue to issue, but they might also have noticed a trend. This I would like you to consider.

There are basically three ways I can present material:

1. If I can attend a meeting, I can attempt to catch the spirit and the basic facts (the wine and the meat) and transmit them to you for consideration and follow-up, if you see fit.
2. I can sometimes abstract technical papers, and present abstracts by others.
3. I can present technical papers in their entirety (space permitting).

The original idea of the *Newsletter* was to accomplish the first. But since there are five or six regional Councils I obviously can't attend all the meetings, so most of my reporting is at the mercy of the local secretaries. Secretaries are people, so I might get:

1. Nothing
2. Abstracts which have been so abstracted that nothing worth printing is left.
3. Excellent abstracts
4. Notes that are so rough I can't interpret them
5. Excellent notes
6. Full texts, poor to excellent

Obviously I do not always have a choice, but when I do, what do my readers want?

1. Wine and meat
2. Abstracts
3. Full texts

And should I stick to reporting Simulation Council meetings per se, or pass up some meeting material in favor of outside material which in my opinion seems more pertinent?

Remember, I don't edit this thing for fun or profit but for readers. Let's hear your wants. If you yell loud enough I'll start a letters column and maybe we can really stir up something!

Bits

Aside from the foregoing plea for feedback, we give you this month (through courtesy of *P. J. Hermann*, their erstwhile Secretary) selected information on the August meeting of the Midwestern Simulation Council held at the General Motors Technical Center.

At this meeting *Robert Kley* (Holley Carburetor) spoke on simulating a "Once-Through Steam Generator"; *R. O. Whitaker* (Allison Div., GM) gave some "Techniques Utilized in the Simulation of Several Nonlinear Devices"; *R. T. Harnett* (WADC) told of improvements in a "Quarter-Square Electronic Multiplier"; *R. M. Howe* (University of Michigan) lectured on the use of analog computers in the "Solution of Partial Differential Equations"; and *R. H. Kohr* (GMTC) discussed "Vehicle Ride Simulation."

Pieces

MIDWESTERN S/C MEETING OF 3 AUGUST ON "TOUGH PROBLEMS IN SIMULATION"

More than 65 people representing 32 different business, industrial, and educational organizations attended the 3 August 1959 meeting of the Midwestern Simulation Council. *Bob Kohr* and the people at the General Motors Technical Center in Warren, Michigan (just north of Detroit) were hosts. The topic of the meeting was "Problems in Simulation," with emphasis on some of the more difficult ones.

The meeting was held in the Research Building of the Technical Center. This is a striking modern structure with hanging stairways and all the appointments necessary to impress the visitor and give the worker an air of professional relaxation on the job.*

Vernon Larrowe (Willow Run Research Laboratories, University of Michigan, Ypsilanti, Mich.), Chairman of the Steering Committee, opened the meeting and introduced *Joseph Bidwell*. Mr. Bidwell greeted the group and described briefly the type and scope of work being done by the Technical Center in general and by the Research people in particular.

---

*Your Ed. has often felt like relaxing at the office on a Monday morning, but we doubt if he looked very professional about it!

Kley on Heat Transfer in Nuclear Reactors

Vern then introduced *Robert Kley* (Holley Carburetor Co., Warren, Mich.). Bob's talk concerned work he had done at Holley in simulating the heat transfer process in a nuclear reactor system** of the type illustrated by the block diagram of Fig. 1.

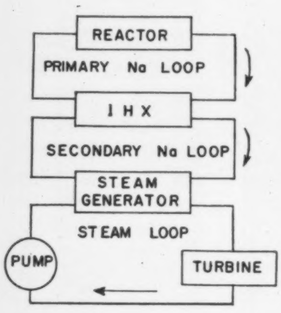

REACTOR
PRIMARY Na LOOP
I H X
SECONDARY Na LOOP
STEAM GENERATOR
STEAM LOOP
PUMP
TURBINE

Fig. 1

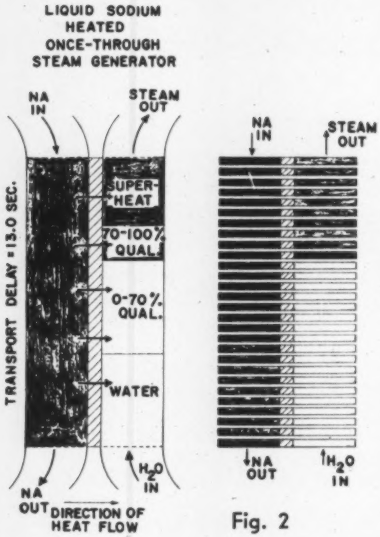
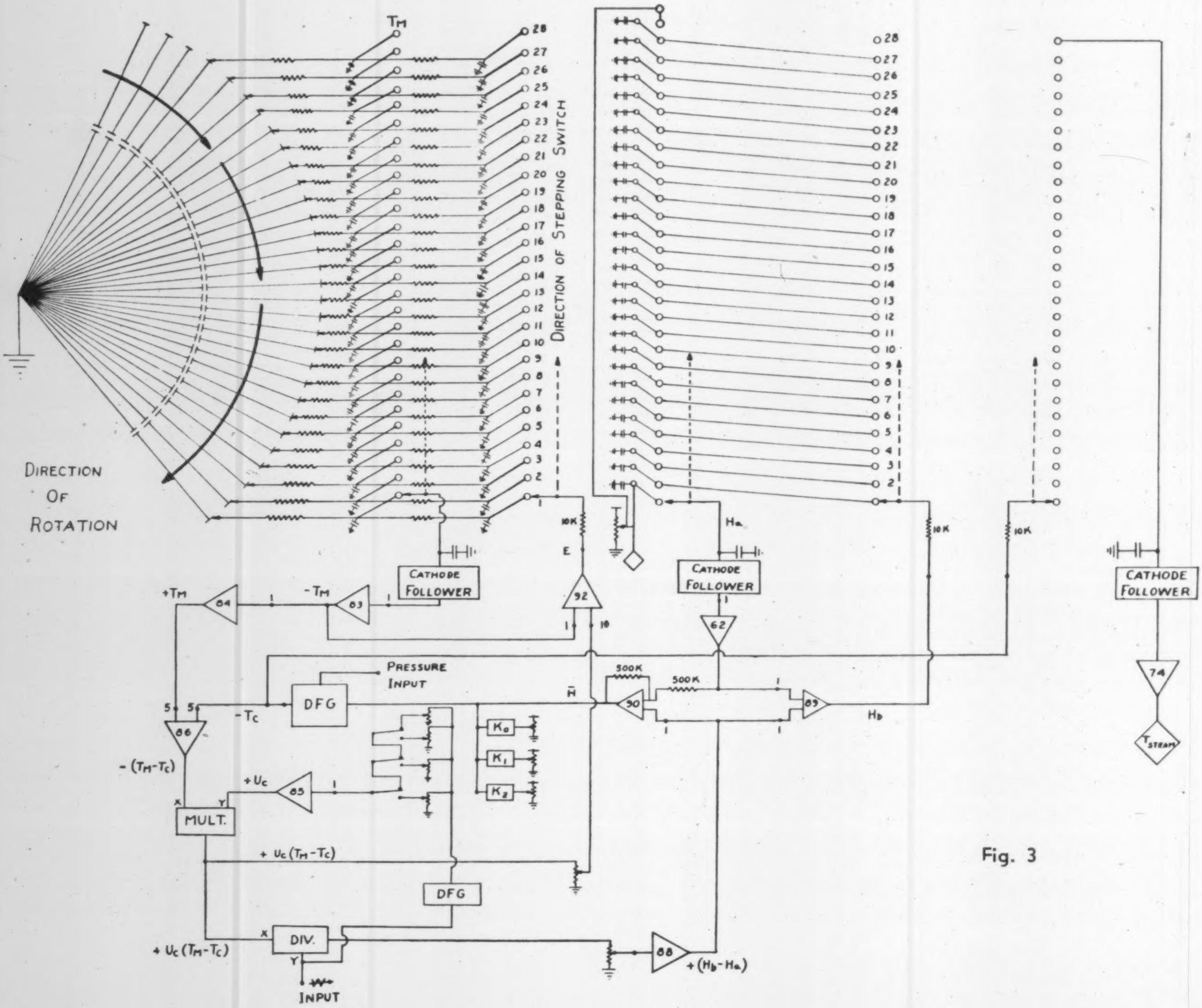

LIQUID SODIUM HEATED ONCE-THROUGH STEAM GENERATOR
NA IN
STEAM OUT
TRANSPORT DELAY = 13.0 SEC.
SUPER-HEAT
70-100% QUAL.
0-70% QUAL.
WATER
NA OUT
H_2O IN
DIRECTION OF HEAT FLOW
NA IN
STEAM OUT
NA OUT
H_2O IN

Fig. 2


T_M
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8
7
6
5
4
3
2
1
DIRECTION OF STEPPING SWITCH
DIRECTION OF ROTATION
10K
E
H_a
10K
10K
CATHODE FOLLOWER
CATHODE FOLLOWER
CATHODE FOLLOWER
$+T_M$
84
$-T_M$
83
92
62
74
T_{STEAM}
PRESSURE INPUT
DFG
$\bar{H}$
500K
500K
90
89
H_b
$-T_c$
86
$-(T_M-T_c)$
$+U_c$
85
K_0
K_1
K_2
MULT.
X
Y
$+U_c(T_M-T_c)$
DFG
DIV.
$+U_c(T_M-T_c)$
INPUT
88
$+(H_b-H_a)$

Fig. 3

**Some carburetors!

Unfortunately, the tape transcription of Bob's talk was so poor that we can only give high-lights of his work. (Bob is scheduled to give a talk "Using An Analog Computer for Both System Analysis and Operator Training on the Enrico Fermi Nuclear Power Plant" at the WJCC, San Francisco, 1-5 May. This talk will cover a larger simulation, a part of which Bob described at the MSC meet.)

The objective of the simulation was to study the heat-transfer processes in a once-through heat exchanger, as illustrated in Fig. 2A. Hot molten sodium from the reactor is passed through a steam-generating heat exchanger into which water is pumped, and out of which superheated steam is taken. Some large temperature gradients exist in this exchanger, both laterally from the sodium loop to the water-vapor-steam loop, and longitudinally in the directions of flow of the two fluid media.

It was desired to simulate the heat-transfer process by considering the exchanger to consist of a large number of one-dimensional heat exchangers stacked one on top of the other in the longitudinal direction, or direction of flow. In Bob's case the number of finite elements was 28, as shown in Fig. 2B. Each of the elemental heat exchangers was considered essentially as a steady-state process. The problem was to take care of the large number of elements in the system when each of the elements operates over a large range of temperature heat-rate flow conditions. Obviously, a large amount of computer equipment would have been required to simulate this many elements in the conventional manner.

The technique used at Holley Carburetor was to construct a sort of hybrid active-and-passive-element simulation. The passive elements simulated the passive heat-exchange processes of each element, the active computer components were used to generate the complicated functional relationships, and a stepping switch operation was devised to permit time-sharing of the active components with the passive components, as shown in Fig. 3. In this way they were able to simulate the operation of this heat-exchanger in steady-state conditions over a large range of operating conditions.

Whitaker on Non-Linear Devices

The second speaker of the day was *Robert O. Whitaker* (Allison Division, General Motors Corpora-

for library, gifts, training course

Electronic Circuitry for Instruments and Equipment

by M. H. Aronson. "Comprehensive source book on instrument circuitry," this complete home-study text includes 458 multiple-choice questions (and answers), 215 illustrations, 10 tables, comprehensive index. Paperbound, 324 pages, 1957 (revised edition). **$2.00**

100 Electronic Circuits

by M. H. Aronson and C. F. Kezer . . . covers amplifiers, oscillators, pulse circuits, phase shifters, etc. Complete with all circuit component values and response specifications. Paper, 180 pages, 1957. **$2.00**

Printed Circuitry

by Allan Lytel. A valuable working tool; includes alternative and recommended practice for each step in design and production of printed circuits; a buyer's guide to special components; and "how to" service data. Paperboard, illustrated, 192 pages, 1957. **$2.00**

Maintenance and Servicing of Electrical Instruments

by James Spencer. Useful to all instrument users, service men, switchboard attendants, testing engineers, and others, this book covers construction, testing, applications, principles of operation and maintenance of all kinds of electrical indicating instruments. Clothbound, 274 illustrations, 280 pages, 1951 (third edition). **$2.00**

Strain Gage Instrumentation

edited by Aronson and Nelson. " . . . a practical text . . . covers fundamentals, basic bridge circuits, typical applications, and surveys typical commercial instruments which use or are used with strain gages." Paper, 110 pages, illustrated, indexed by company, author, and subject, 1958. **$2.00**

Nuclear Reactors for Industry and Universities

edited by E. H. Wakefield. The several distinguished authors and editor Wakefield cover types, availability (1954), operation, protection, control, experiments, legal aspects, and present a detailed cost study. Cloth, 92 pages, illustrated, 1954. **$2.00**

Digital Techniques for Computation and Control

by Martin L. Klein, Harry C. Morgan, Milton H. Aronson . . . FIRST comprehensive survey of basic digital techniques . . . includes basic principles, basic circuits, components and available commercial equipments . . . Dynamic digital material thoroughly covered in 394 pages. Cloth bound with dust jacket, illustrated, 5½" x 8½". **$6.00**

Process Control

by A. J. Young. A "must" for all who have to do with the automatic control of industrial processes, this book combines for the first time the practical "how" and the theoretical "why". Paperbound, 134 pages, 1957 (second printing). **$2.00**

Operation and Care of Circular-Scale Instruments

by James Spencer. Includes "trouble" charts for d-c, and for a-c instruments; covers d-c instruments, a-c ammeters and voltmeters, wattmeters, frequency meters, power factor meters and synchroscopes. Clothbound, 90 pages, 1949. **$2.00**

Process Control Analysis

by M. H. Lajoy and E. A. Baillif. An essential first step in analysis of closed-loop controlled processes via frequency response of the system. Clothbound, 72 pages, 1956. **$2.00**

Mechanical Measurements by Electrical Methods

by H. C. Roberts . . . describes gaging methods based on variations of capacitance, inductance, resistance, as well as photoelectric piezoelectric, thermoelectric, acoustic, and other methods . . . covers principles of bridge and potentiometer circuits, plus required and available equipment. Second edition, cloth, 368 pages, 1951. **$2.00**

Scientific and Industrial Glass Blowing

. . . and Laboratory Techniques by W. E. Barr and Victor J. Anhorn. New revised edition covers construction in detail. Explains operating principles of all pieces. Includes review of history, and most recent developments. Original edition acclaimed "best of its kind—not only on glass blowing but hundreds of techniques." Paper, 408 pages, 300 illustrations . . . new edition 1959 **$5.00**

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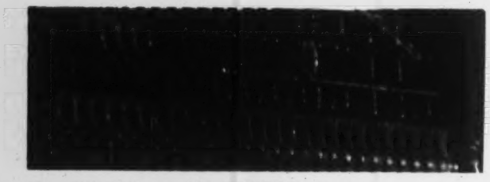

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16. Only diode function generators utilizing resistors, potentiometers, and diodes of equal quality to those in computing networks.

17. Only diode function generators with individual hi-lo gain positions for *each* segment.

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32. Accuracy of computing networks at least 0.01%.

33. Lowest computer cross-talk—rejection greater than 2,000 to 1.

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34. Greatest available problem capacity per dollar—by 20%.

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36. Output tube filaments operate with DC bias for maximum life.

37. Centralized overload indication for quicker trouble-shooting.

38. Only computer with hermetically sealed transformers.

39. Choppers employ double-contacts in parallel for maximum life.

40. Plug-in relays and step switches throughout for least down time.

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42. Quickest trouble-shooting by automatic problem check.

43. Costliest and best patching system for lowest programming cost thru maximum reliability of patchcord connections.

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45. Separate power-supply venting minimizes room heat load.

46. Exclusive equipment-door packaging for free access and quick maintenance *without* shutdown.

47. Insulated patchboard prevents costly shorting accidents.

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49. Fully transistorized ADRAC system with plug-in logic modules.

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The MC-5800 can SOLVE MORE OF YOUR PROBLEMS

51. Exclusive dynamic memory makes automatic iterative solution of statistical or optimization problems a reality.

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54. More computer capacity per dollar means more solutions.

55. Solution of problems with up to 15 amplifiers in closed loops.

56. Starting with as few as ten amplifiers, at a cost of little more than the cheapest available computer, you can build to a complete computing center of unsurpassed performance.

57. Add-on capacity up to 134 amplifiers, 30 electronic multipliers, 18 diode function generators, 2 time-delay generators, 8 relays with amplifiers, 4 bi-variable function generators, 6 servos, 8 function switches—all field-expandable without mechanical rework or rewiring.

58. Add-on features include automatic problem check, integrator rate test, high-speed repetitive operation, dynamic memory, expanded-time base, compressed-time base, servo-set potentiometers, and ADRAC (Automatic Digital Recording and Control) system—all field expandable without mechanical rework or rewiring.

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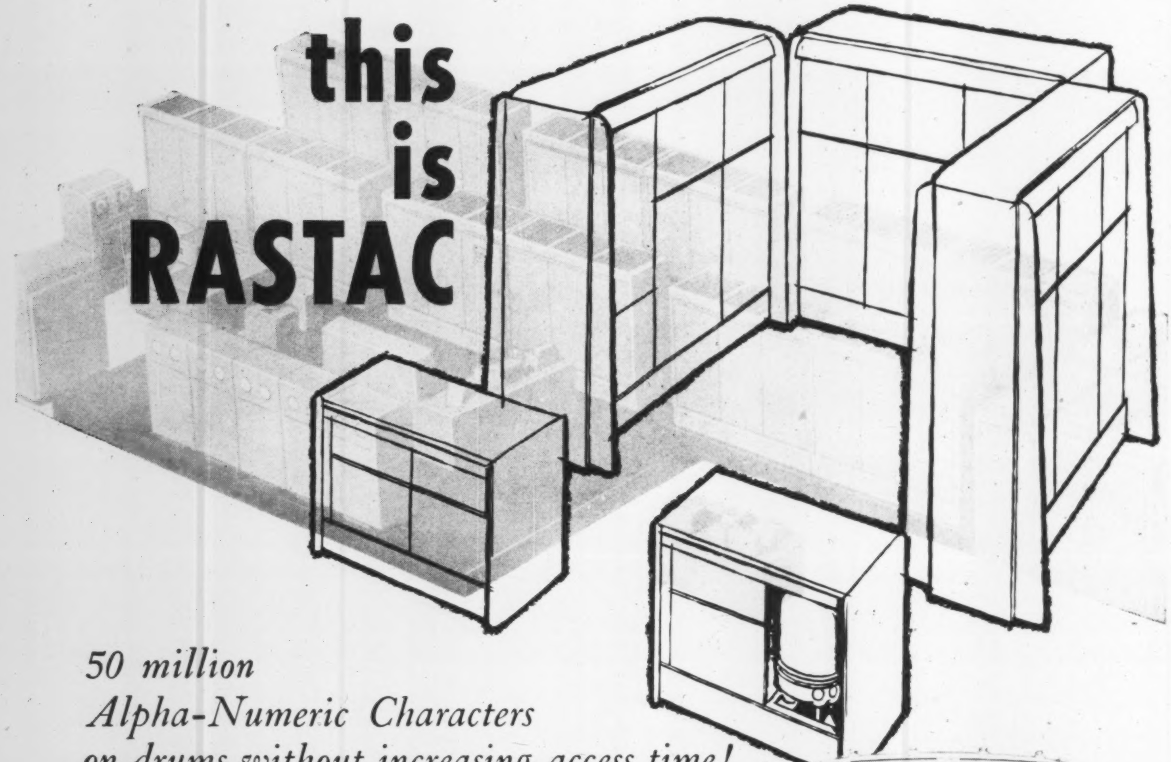

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A complete LFE RASTAC System may include from one to thirty-three high density magnetic file drums (LFE Type HD), plus three cabinets of control and power supply elements. So RASTAC is actually a building-block system of reliable magnetic modules.

A RASTAC System can be assembled as a one drum unit with a storage capacity of 1.5 million characters. Or the maximum RASTAC is available with 33 HD drum units for a total storage capacity of almost 50 million characters.

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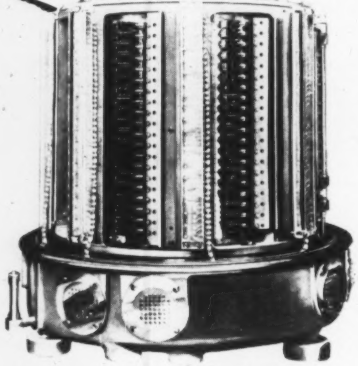

RASTAC can be used in conjunction with any general purpose digital computer.

We suggest you consider the RASTAC System if you require fast access to mass data storage. Descriptive literature is available on request. Write to Department 3-1

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tion), whose talk on "Techniques Utilized in the Simulation of Several Non-Linear Devices" was a collection of descriptions of some special circuits that he had developed for generating certain non-linearities in connection with the simulation of a jet engine. Although the circuits are somewhat specialized, we reproduce them here for the benefit of others who might have similar problems. As Mr. Whitaker's notes were in reproducible form it is likely that those who would like more details can get a copy by writing to him.

A study of a magnetic-amplifier's predicted performance characteristics revealed that the transfer function should be as shown in Fig. 4.

The relatively simple circuit of Fig. 5 was used to simulate this characteristic.

This, we note, involves only a function generator to provide the non-linear action. The curve between the origin and Pa is described by $\gamma = \tau x - x^2$. The circuit operated very well.

The computer engineer may well keep in mind the ready adaptability of function generators to applications like this.

A magnetic relay of the bi-directional type was characterized by the action shown in Fig. 6.

The circuit considered best for the simulation of this action is shown in Fig. 7.

The use of a single pot at pc causes the points of return to zero to be dependent. Independent operation could be obtained by using separate potentiometers.

The positive feedback circuit should be kept in mind by the computer engineer and used for non-linear actions of the type shown.

When a certain type of clutch is activated, the bands tighten, squeezing out oil. Only after the oil has been squeezed out does the clutch engage, but when the clutch is deactivated, the bands loosen and the clutch disengages instantly, as shown in Fig. 8.

The relative complexity of the circuit finally employed seems to indicate that there should be something simpler.* It is shown in Fig. 9.

If applications arise in which the speed of operation required will be such that the delay associated with the return to zero cannot be tolerated, trigger circuits can be added to eliminate the network of resistors and diodes.

Rotary compressors used in jet engines have a highly non-linear relation between speed, air flow through the compressor, and pressure ratio across the compressor as shown in Fig. 10.

The problem of determining just what speed corresponds to a given pressure ratio and air flow becomes a problem of interpolation between the various speed lines.

One shortcoming of many interpolation techniques is that completely vertical portions of curves cannot be set on the function generators. And furthermore the shape of the curves may be such that linear interpolation introduces large errors.

A difficult map may be converted

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*Have our readers any ideas? I have. —Ed.

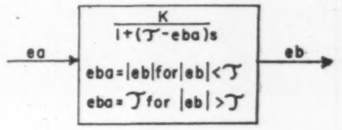

Fig. 4

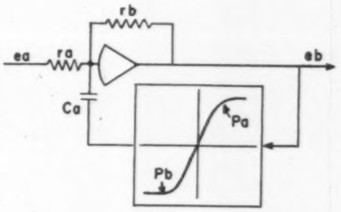

Fig. 5

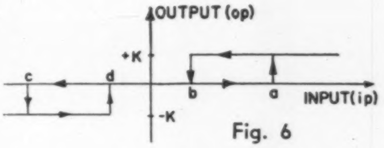

Fig. 6

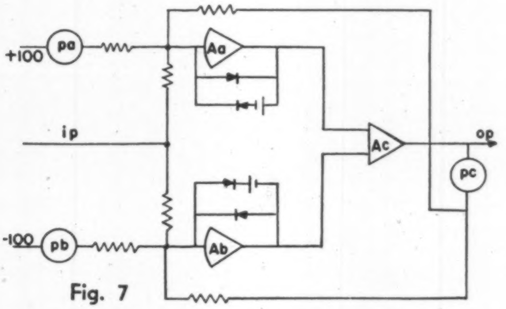

Fig. 7

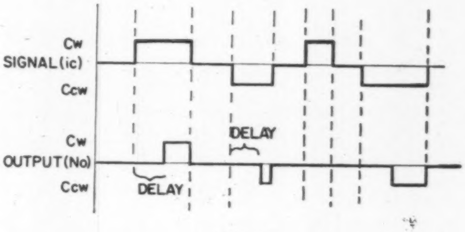

Fig. 8

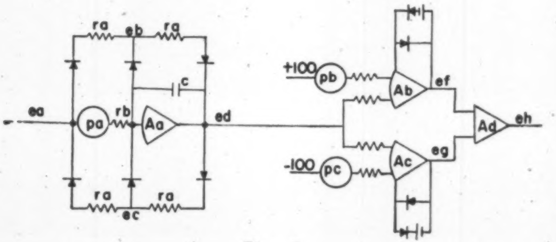

Fig. 9

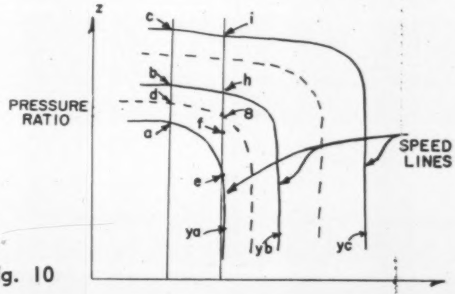

Fig. 10

into another one to give greatly improved results. Such a map would result if a center C is chosen in Fig. 10 and radial lines drawn, as shown in Fig. 11.

Now reading points in the polar form, θ and r, and replotting in the rectilinear form gives a new map, as shown in Fig. 12.

Interpolation will be much better than in the map of Fig. 10, but a more complex computer setup is required. There are numerous variations of this method; the basic principle is to obtain a coordinate system in which the function generators generate essentially horizontal lines.

A technique for paralleling function generators is sometimes helpful. Suppose it is necessary to set up a curve, as shown in Fig. 13.

Accuracy requirements call for breakpoints as indicated, but suppose that function generators having only 10 breakpoints are available.

Interlacing two function generators as shown in Fig. 14 may be the answer.

Interlace may be in sections as indicated or point by point.

Breakpoints may be determined on the computer by feeding a value of x to the system and adjusting the function generators to give the desired value of y. If computer time is not available, then a ruler and pencil may be used in a graphical analysis to plan the breakpoints.

Any number of function generators may be so paralleled, but trouble from drift and noise becomes bothersome as the circuitry becomes more complex.

The above discussion of two methods of map simulation is not intended in any way to indicate a general method for simulation of all maps. Most methods will work on particular types only. The computer engineer must study the map to be simulated and decide as to what method, if any, will be adequate for his purpose. A very definite need still exists for a special computer component which will satisfactorily simulate maps of all types.

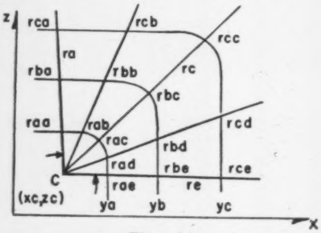

Fig. 11

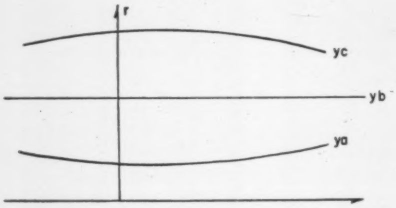

Fig. 12

Harnett on Electronic Multipliers

The third speaker was *R. T. (Bob) Harnett* (Wright Air Development Center, Ohio). Bob began his talk, "Improvements in an Electronic Multiplier" by observing that the previous speaker, *R. O. Whitaker*, had commented that you should avoid the use of multipliers whenever possible. However, if you've got to use one, Bob thought the multiplier he was about to describe would be the one to use.

Bob's paper described modifications made by WADC in the development of their REAC computer. He distributed copies of a paper on the subject which is so thorough (91 pages) that we won't attempt even to abstract it here, but will only give you the "Contents" so that you can decide whether you'd like to write Bob for a copy.

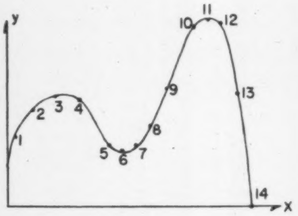

Fig. 13

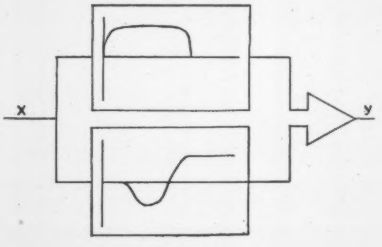

Fig. 14

The multiplier is basically a quarter-square multiplier with four-quadrant capability and a straight-line addition to the DFG parabola to provide a monotonic function. The straight line is removed later on in the output stages of the multiplier operation.

Points covered in detail in Bob's report are: Introduction: Theoretical Considerations: Principles of Operation; Diode Circuits; Ideal Dither and Error Correction. Multiplier Installation at WADC. Also:
Performance Characteristics: Static Accuracy; Test Methods for Static Accuracy in Product Modes; Typical Results for Static Accuracy in Product Modes; Static Accuracy in Square Mode; Static Characteristics in Divide Mode; Square Root in the Divide Mode; Phase Shift Characteristics; Major Areas of Research on Product Improvement; The Effects of Dither on Diode Characteristics; The Effect of Inductive Resistors on Distribution of Dither; Methods of Temperature Compensation; Long-term Drift; Influence of Reference Voltage Magnitude. Summary. Appendix: Multiplier Control Panel; Checking a Network at the Control Panel; Checking a Network in a Multiplier Slot; Adjustment of the x and x^2 Lines; Adjustment of Dither Amplitude and Frequency. References. Bibliography.

The first question after Bob's presentation came from *R. M. Howe* (University of Michigan, Ann Arbor): "How frequently do you have to calibrate these things in order to hold errors of the sort you show?"

Bob replied that at one particular computer station which they did not calibrate for a two-week period the errors were in the same range as their temperature shift: 10 mv. Since they had been talking about over-all accuracy of 50 mv they were well satisfied.

Bob was next asked, "Were the machines left on quite a while or were they turned off?"

Bob answered that they were left on. "This of course would have been one of the fixes for the diode drift. We could have left the power supplies on and stabilized the temperature. But the adjustments are done when the unit is out of the machine and cooling off. With the staff that we have we don't anticipate multiple-shift operation. We have a slow warm-up process to protect the tubes, so leaving them on all the time doesn't seem desirable—from the safety standpoint as well as others."

"How much of the dither frequency do you have in your output?"

SPEAKING WITH EASE®

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Time Delay Unit Simulates Fluid Transport

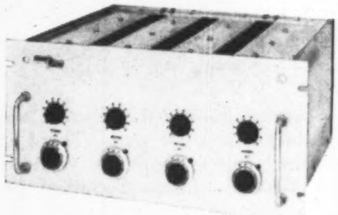
Used to Study Reactors and Chemical Processes

A prominent feature of nuclear power plants and many chemical processes is the flow of fluids from one energy exchange point to another. In the case of reactors there is the flow of coolant from core to heat exchanger and back; in chemical processes, the movement of chemicals from one reaction chamber to another. When simulating such systems it becomes necessary to introduce rather long time delays corresponding to the time the fluid is in transport but otherwise unchanged.

The delays required are likely to fall in the range of a tenth of a second to ten seconds. Because fluid turbulence removes sudden changes in the temperature or chemical composition of fluids, the signal to be delayed usually consists of low frequency components – on the order of one cps or less.

The EASE 1152 transport delay shown below was developed to cope with these conditions.

Panel Controls Select Delay Quickly and Precisely



Four Model 1152 delay units are shown above mounted in 8¾" of rack space. In operation each delay unit must be supplemented by three operational amplifiers. Each unit has a 10-position switch (top) for selecting the integral number of seconds and a 10-turn dial (bottom) for selecting the fractional increment. Signal delay is continuously adjustable from about .010 secs to 10.000 secs. The shape and amplitude of the signal remain essentially unchanged. (Amplitude error is less than ±.01% at dc and ±0.3% at highest specified input frequency.) In this respect the unit is far more accurate than magnetic storage delays which are subject to considerable dc drift.

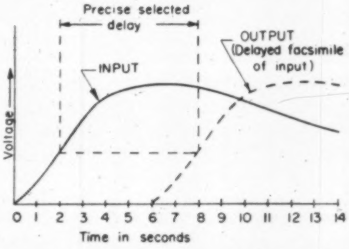


Figure 1. Graphic representation of a delayed signal.

The maximum usable delay depends upon input frequency. In order to operate with specified time accuracy, the delay (t) in seconds should be limited to

$$t = \frac{1.2}{f} \qquad (1)$$

where f is the frequency of the highest frequency component of interest. Thus, if the highest component is lcps, 1.2 seconds is the maximum delay. The slower signals commonly encountered may be delayed for several seconds as diagramed in Figure 1. Moreover, maximum delay time may be doubled, tripled or quadrupled by cascading delay units. The effect is to add delay times while preserving percentage accuracy.

Note that it makes no difference what time scale is used in the problem. For example, if solution time is doubled, maximum delay time also doubles because frequency in equation (1) is reduced to one-half.

Design Optimizes Accuracy, Reduces Need for Amplifiers

The basis of the time delay is a circuit which induces phase shift that varies linearly with input frequency. Thus, for example, if frequency doubles, phase shift doubles and time delay remains exactly the same.

In the circuit used, phase shifts up to 425° occur as a linear function of frequency. This range is approximately 40% larger than that which can be achieved using the Padé approximation. Figure 2 shows phase error of only 1.1% at 425°.

The total possible error in delay time is equal to the phase error plus a slight error introduced by the finite resolution of the delay control. Resolution error amounts to only 0.25% of value for delays in the range of 0.4 to 10 seconds.

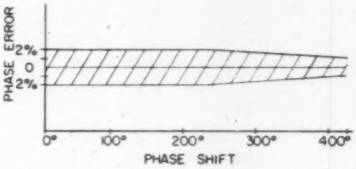


Figure 2. Phase error plotted against phase shift. 425° phase shift corresponds to maximum usable delay (t = 1.2/f).

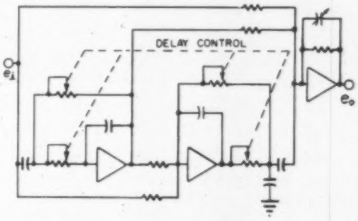


Figure 3. The delay circuit used. Note that only three operational amplifiers are required. This simple circuit possesses the complex transfer function required for accurate delays: 4th order in the numerator and 5th order in the denominator.

Write for complete specifications on Model 1152.

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"A good question. We have something like 50 mv. That is fairly good."

Vern Larrowe (Willow Run Research Center, Ypsilanti, Mich.) said, "I was interested in your procedure to make these functions monotonic. We use a sort of reverse procedure to improve the accuracy of function generators; we approximate the function as a straight line and then use the function generator to get the difference. You're working it backwards. Does this impair the accuracy?"

"I think I see what you're driving at," Bob answered. "When we extract the straight line we might magnify errors in the function. With maximum input something like 575 volts is required at the output, but most of this is extracted before the final stage so that the output is never greater than 100 volts. Thus you never see the effect of the straight line and the errors are just those caused by the diodes."

Howe on Partial Differential Equations

The next speaker was *Dr. R. M. (Bob) Howe* (Department of Aeronautical Engineering, University of Michigan, Ann Arbor), who talked on the use of analog computers in the "Solution of Partial Differential Equations" which, like the preceding talk, was based on a "book"—49 pages, including 18 figures. Again we will give only the section headings, and you can write Bob for a copy if you're interested in the details. (Your Ed. couldn't abstract this one if he had to.)

Introduction: Requirement for the Solution of Partial Differential Equations; Importance of Error Analysis. Solution by Separation of Variables: Basic Equation for Heat Flow; Method of Separation of Variables; Computer Circuit for Solving the Boundary Value Problem; Generation of the Fourier Coefficients; Analog Computation of the Complete Series Solution; Additional Eigenvalue Problems; Use of Normal Coordinates to Represent a Continuous System; General Usefulness of the Method of Separation of Variables; Solution by Difference Techniques; One-Dimensional Heat Flow; Estimated Accuracy of the Difference Method Using a Taylor Series Expansion; Estimated Accuracy of the Difference Method Using Separation of Variables; Higher-Order Central Differences and Backward Differences; Heat Flow with Mixed Boundary Conditions; Two-Dimensional Heat Flow; Spherical and Other Boundary Shapes; Change of Variable to Group Stations Unevenly; Solution of Heat-Flow Problems in Semi-Infinite Media; Non-linear Heat-Flow Problems; Problems with Moving Boundary Conditions; Displacement of Thick Beams Including Transverse Shear Effects; Beams with Damping; Stability of Beam Circuits; Representation of Plates and Built-Up Structures; Comparison of Passive-Circuit Methods with Electronic Analog Computer Techniques. References. List of Figures.

ACE COMPUTER COMPANY
ACE
LITTLE GEM Model I-B124
Ruffell

"I'm beginning to doubt your loyalty to the Ace Computer Company Henshaw . . . ."

Bob's subject raised several questions, particularly from our friend *P. J. Hermann* (Goodyear Aircraft Corporation, Akron 15, Ohio), but we will not repeat them here as they would be out of context.

Kohr on Vehicle Ride Simulation

Last speaker of the day was *Bob Kohr*, the host, who spoke on "Vehicle Ride Simulation." Again we won't give details, but this time for different reasons:

1. Much of what Bob* talked about had been presented before at other meetings, one of which was the Eastern Joint Computer Conference and another the National Simulation Conference in December, 1957.

2. The same ground will be covered again at the WJCC in San Francisco in May.

3. We don't have the details.

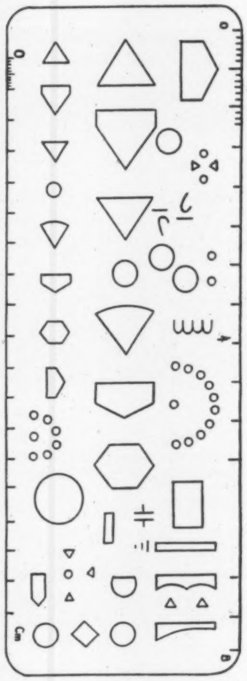


Fig. 15

For the most part Bob reviewed the equations of motion for an automobile (which are not unlike the equations for an airframe), showed some of the results obtained, and compared analog with digital computer (IBM 704) results. The two compared favorably—so Bob concluded that the digital computer was doing a pretty good job!

* * *

Tours following the meeting were conducted in three parts. There was a movie setting forth the virtues of the General Motors Technical Center, a bus trip around the Center, and a tour of the computer laboratory. A brochure is available and was distributed which gives some facts about the Center. One usually expects such a brochure to be exorbitantly complimentary. However, in this case the actual physical installation very nearly lives up to the glowing words of the brochure. General Motors constructed this Center for show as well as for research, and when General Motors does things it does things in a BIG way.

One interesting feature of Bob Kohr's computer laboratory is a mockup of an automobile body which is hydraulically moved to simulate an automobile ride in response to computer signals. Test engineers use the setup to obtain subjective evaluations of various suspension systems as simulated in the computer. The basic frequency response of the hydraulic system was between three and four cps, but had been improved by various techniques so that the response in roll, pitch, and vertical motion isn't bad to about seven cycles. Apparently this is enough to give the engineers a "feel" for the system being simulated.

---

*We hope that at future Simulation Council meetings the speakers won't all have the same first name!—Ed.

He Went Thataway!

Charles Sobel to Mergenthaler Linotype.

Letters (not necessarily simulated)

"Dear John:

"I am enclosing one of our templates and several sheets of paper illustrating the use of the template. Please note that the template was designed in such a way that elements commonly used in conjunction with one another were placed in a logical sequence. In particular, note the placement of the diodes and potentiometers in a position such that they lend themselves to the construction of a limiter diagram. Note also the placement of the pot at the output of the amplifier and the pot in the feedback of the integrator.

Sincerely yours,

J. E. Sherman, Manager
Analog Computing
Lockheed Aircraft Corporation
Missile Systems Division
Sunnyvale, California"

Doctor: "Where does it hurt when you take a square root?"

Thanks, Jack. Seems a handy arrangement (Fig. 15). The subject of standardizing the symbols for analog computer diagrams might be something the Simulation Councils could help with. Some progress has been made, but much must be done before any worker in the field can read all other people's diagrams.

"Dear Mr. McLeod:

"The enclosed report, 'Computers for Aircraft Simulation', might be of interest to engineers who are faced with the problem of evaluating the relative merits of AC and DC computing techniques with respect to a special purpose application such as the operational flight trainer.

"A few copies are available at the M.I.T. Electronic Systems Laboratory for general distribution.

Very truly yours,

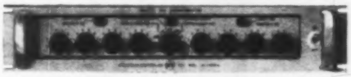
Mark E. Connelly,
Project Engineer"

Thanks, Mark. This volume, together with the one you previously sent me, certainly present a comprehensive coverage of the subject. So that others interested can determine the usefulness of these reports in their work, I am giving the following abstracts:

"Simulation of Aircraft"—This report is an outgrowth of a one-year study of the equations of motion and the computing techniques used in the aerodynamic computer section of Operational Flight Trainers. One of the objectives of the study was to standardize and simplify, insofar as possible, the mathematical model used to represent an aircraft in flight. In this connection, an extensive analysis of axis systems, basic dynamics, and aerodynamic coefficients was carried out. Digital and analog simulation studies were employed to determine allowable simplifications in the equations of motion. The results of this work are summarized in the report.

"Computers for Aircraft Simulation"—This report is the concluding work on a one-year study of the equations of motion and the computing techniques used in the aerodynamics computer section of Operational Flight Trainers. A review of the characteristics of basic 60 cps, 400 cps, and DC analog computing techniques is presented with emphasis on the relative applicability of these techniques to the unique requirements of the OFT problem. It is concluded that 400 cps techniques would give more than acceptable performance and would offer substantial advantages with respect to cost, size, maintenance and power consumed. In conclusion, several suggestions are made concerning OFT acceptance procedures, the matching of the OFT to the actual aircraft, and standardization.
Although the emphasis is on flight simulators used for training purposes, the material presented is generally applicable to the entire field of flight simulation.

INSTANT INDICATION
of Voltage Tolerance with NLS Series 50 Comparators



NEED TO DETERMINE IF INPUT VOLTAGES ARE WITHIN PRESET LIMITS? Within 90 milliseconds, NLS transistorized voltage comparators indicate voltage tolerance through colored bulbs . . . and transmit go/no-go commands to electrical control and warning systems. Here are complete voltage comparison systems in single, compact packages — ready to use in a wide range of applications in automatic go/no-go testing, decision making, and automatic control. Model 50 is for manual limit setting—Model 51 for applications where limits are already in analog voltage form. Also available are Programmed Comparators for remote control of limits in automatic systems. Write NLS.

MODEL 50 SPECIFICATIONS: Ranges: ±9.999/±99.99/±999.9 volts . . . ±0.01% accuracy easily checked against external standard cells . . . 10 megohms input impedance . . . threshold sensitivity: ±0.005% of full scale, each range . . . indicating speed: 90 milliseconds . . . 3½" high by 15¼" deep for 19" rack.

NLS *Originator of the Digital Voltmeter*

non-linear systems, inc.
DEL MAR (SAN DIEGO), CALIFORNIA
NLS — The Digital Voltmeter That Works . . . And Works . . . And Works!
CIRCLE 78 ON READER-SERVICE CARD

NOW! A NEW CONCEPT IN COMPUTER DESIGN SETS A NEW STANDARD OF VERSATILITY AND VALUE!

THE FULLY-TRANSISTORIZED

RPC-4000 ELECTRONIC COMPUTING SYSTEM

CIRCLE 79 ON READER-SERVICE CARD

The RPC-4000 is a new, fully-transistorized electronic computing system with the largest memory, greatest problem-solving capacity and flexibility in the low- or medium-priced field. It is the latest member of a growing family from the people whose LGP-30 has become the world's leading small-scale computer.

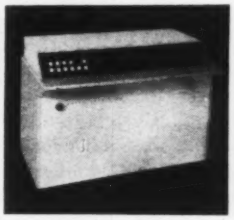
Wide range of applications: the RPC-4000 has been designed for engineering, scientific, business data processing and management control functions. Such jobs as product and process design, statistical analysis, research, inventory control, payroll and sales analysis are all well within its capabilities.

Easy to use: the RPC-4000 is simple to program and operate. Royal McBee compiling and translating routines allow even non-technical personnel to obtain maximum results. Versatile command structure gives programming speed and flexibility.

Available at low cost: high capacity, flexibility and ease of operation make the RPC-4000 the outstanding computer value on the market today.

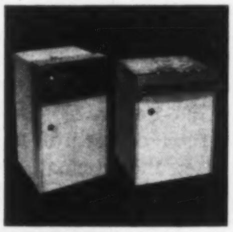
Minimum operating costs: the RPC-4000 requires no site preparation or special maintenance. It is powered from any ordinary wall outlet.

Continuing assistance: users benefit from free training, an information exchange service, and library of programs.



Heart of the RPC-4000 system is a new transistorized computer with advanced design concepts that provide substantial computing speed and capacity in a low-cost unit. Magnetic memory drum stores *8008 words*. Operating speeds are as high as 230,000/minute.

Standard input-output is a tape typewriter system which includes a Royal electric encoding-decoding typewriter complete with desk and chair, plus a tape punch-read console. Read speed is 60 characters/sec., punch speed 30 characters/sec. Typewriter, punch and reader may be interconnected in any combination for both on-line and off-line operations.



A new 500 character/sec. photoelectric tape reader and a 300 character/sec. punch are available as optional input-output equipment. A magnetic tape unit and a line printer will be available soon. As many as 17 input-output devices (60 with minor modification) may be connected on-line to the basic system. All peripheral equipment is under automatic program control of the computer.

Royal Precision Corporation

Royal Precision is jointly owned by the Royal McBee and General Precision Equipment Corporations. RPC-4000 sales and service are available coast-to-coast, in Canada and abroad through Royal McBee Data Processing Offices. For full, detailed specifications on the new, transistorized RPC-4000, write **ROYAL McBEE** data processing division, Port Chester, N. Y.

CIRCLE 79 ON READER-SERVICE CARD

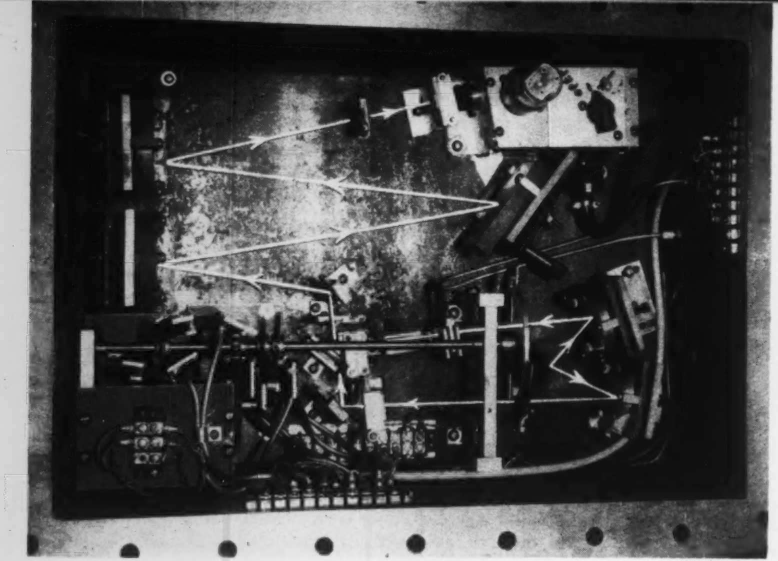


FIG. 1. THE ANALYZER in explosion-proof housing. Layout follows that shown in Fig. 2.

NEAR-IR SPECTROMETER ANALYZER

This infrared plant-stream double-beam spectrometer analyzer operates in the near infrared, uses a lead sulphide photoconductive detector, electric ratio recording, a reflection grating for the dispersing element, a germanium filter to remove higher orders, and magnetically-operated sealed-glass switch rectifiers. It is used to analyze for 25% n-propyl alcohol in n-hexane. Features include low cost, versatility, sensitivity, and low maintenance.

A. M. BARTZ, The Dow Chemical Company

CONCENTRATION of n-propyl alcohol (app. 25%) in a stream of n-hexane is to be controlled within ±1%. The problem is that of providing a signal proportional to the concentration of this n-propyl alcohol. The percent transmission of infrared through a sample is proportional to this concentration; this is measured by an infrared analyzer.

The principle often used in double-beam spectrometers to measure percent transmission is that of the optical null. Here an optical attenuator is driven into the reference beam by a servo motor until the reference beam intensity is equal to that of the sample beam. The position of the attenuator is then a measure of the percent transmission. In plant stream analyzers, where the recorder is usually far removed from the analyzer, the attenuator is positioned by selsyns. However, this arrangement requires precision parts for the attenuator, and span adjustment is difficult; it is more desirable to record percent transmission without using a moving attenuator. This can be done by obtaining an electrical measure of the intensity of each beam and recording the *ratio* of the two signals. The method used in this analyzer to obtain an electrical measure of the intensity of each beam is that of chopping the beams at different frequencies, permitting signal separation on a frequency basis.

The first step in designing any infrared analyzer is to look at the infrared spectrum of the constituent to be measured and those of the constituents of the rest of the stream to select a sensitive wavelength. It is fortunate if this constituent has a usable absorption band in the near infrared (0.7 to 3 microns) for the following reasons:

(1) Source energy (due to the black-body radiation curve) is greatest in the near IR.

(2) Sensitive photoconductive detectors can be used in the near IR.

(3) The near IR represents the overtone region where molecules absorb radiation much less strongly than they do in the normal (fundamental) infrared region, allowing the use of cells with longer path length. This eliminates some sample-flow problems.

(4) Inexpensive glass transmits near-infrared radiation and hence can be used for the optical components.

(5) Commercially available and inexpensive glass-sealed lamps serve acceptably as a source of near-IR radiation.

It was found that n-propyl alcohol has an overtone band at 2.08μ, which is used in this analyzer.

Optics

The operation of the analyzer is easily shown by following the optical path of the light (Fig. 2). The

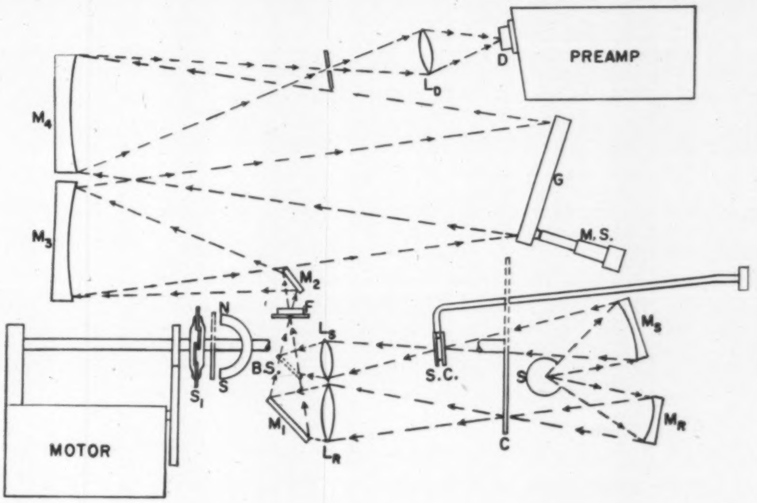


FIG. 2. OPTICAL path of the near-IR spectrometer.

source S is a standard commercial projection lamp. Its glass envelope, except for a window, is aluminized by vacuum evaporation to remove spurious light. The light from the reference beam source mirror M_R is chopped at 58 cps by the outer part of the chopper C, passes through a glass focusing lens L_R, and is reflected by plane mirror M_1. The beam-splitter plate (B. S.) has a polka-dot pattern of evaporated aluminum spots that transmits one-half and reflects one-half of the light falling on it. The reflected half of the reference beam is lost, while the transmitted half is focused on the entrance slit F.

The light from the sample beam mirror M_S is chopped at 24 cps by the inner part of chopper C, is passed through the sample cell (S. C.) where it is attenuated due to absorption by the sample, passes through focusing lens L_S and has one-half reflected by the beam splitter B. S. to a focal point at the entrance slit F. In this beam the half transmitted by the beam splitter is lost. Skipping the function of the optical filter F for the moment, the now combined beam is reflected by plane mirror M_2 onto the collimating mirror M_3. The light leaving M_3 is parallel and fills out (totally illuminates) the grooved reflection grating C, which disperses the light into a spectrum that is presented at the exit slit by mirror M_4. The angle of the grating with respect to M_3 and M_4 determines the wavelength that will fall on the exit slit. Higher-order wavelengths than the one of interest also would fall on the exit slit, but these have been removed by the zinc-coated germanium filter F. The grating angle and hence the wavelength is adjustable by the micrometer screw (M. S.), allowing this analyzer to be adapted readily to other problems.

The light from the exit slit is focused by lens L_d onto the lead sulphide photoconductive detector D.*

Construction

The analyzer is mounted in an explosion-proof housing with outside dimensions of approximately 21″ x 14″ x 9″ (Fig. 1). The orientation of the components is shown in Fig. 2. The light-beam chopper is visible with the inner portion having a 180° opening, while the outer portion, which is adjustable with respect to the inner portion for phasing, has two 90° openings. The 2½-mm sample cell has ⅛″ stainless steel tubing leading through the analyzer housing and tapping into the plant stream. The analyzer is located as close to the plant stream as possible for minimum velocity-distance delay in its response. The response of the analyzer itself is essentially instantaneous. A sample flow of approximately 10 cc/min, which can be returned to the plant stream or collected, is sufficient for fast continuous analysis. The rectifiers are visible near the drive motor in lower left corner. The electronic chassis also is in an explosion-proof housing (same size) with all interconnections made through sealed conduits.

Adjustments and Performance

As an electric signal representing each beam is available, it is possible to adjust the span and operating range simply by adjusting two potentiometers. This is particularly convenient during plant startup where concentrations may vary greatly, but it is desirable that they be known. For example, during startup the analyzer can be made to read full scale for 0% to 100% concentration change; after the process has settled down it can be adjusted to read full scale for 20% to 30% concentration change. It could also read 0% to 10% or 40% to 50%, as desired.

This analyzer has a random noise level corresponding to a 0.01% change in concentration of alcohol. The operating range can be anywhere between 0% and 100%, although with reduced sensitivity for concentrations far removed from the expected concentration for which the instrument was specifically designed. When operating near the intended concentration this analyzer will detect a change in concentration of n-propyl alcohol of 0.1%.

Electric Signal

The electric signal from the detector consists of

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*Eastman Kodak "Ektron" detector 4x4 mm

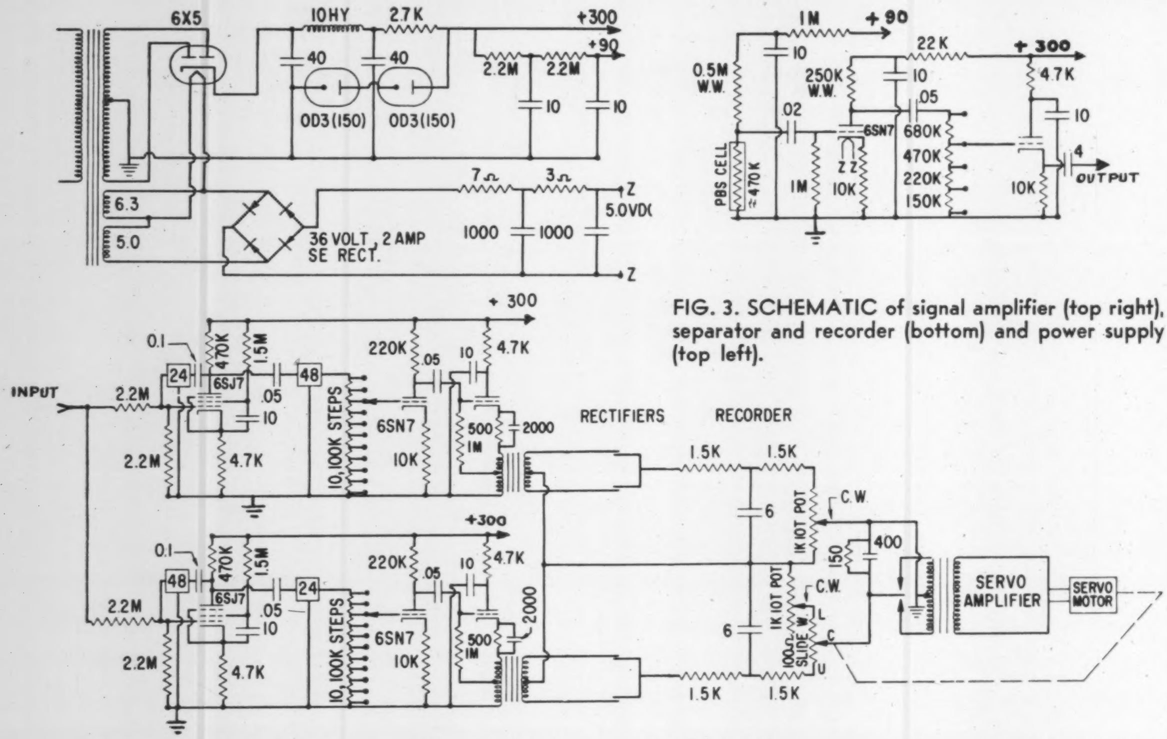

6X5
10HY
2.7K
+300
+90
40
40
2.2M
2.2M
0D3(150)
0D3(150)
10
10
6.3
5.0
7Ω
3Ω
Z
5.0VDC
36 VOLT, 2 AMP
SE RECT.
1000
1000
Z
1M
+90
10
22K
+300
0.5M
W.W.
250K
W.W.
10
.05
4.7K
.02
6SN7
680K
470K
220K
150K
10
PBS CELL
≈470K
1M
10K
10K
4
OUTPUT
+300
0.1
24
470K
1.5M
6SJ7
48
220K
.05
10
4.7K
INPUT
2.2M
.05
10
6SN7
500
1M
2000
2.2M
4.7K
10,100K STEPS
10K
RECTIFIERS
RECORDER
1.5K
1.5K
C.W.
6
1K 10T POT
+300
0.1
48
470K
1.5M
6SJ7
24
220K
.05
10
4.7K
150
400
2.2M
.05
10
6SN7
500
1M
2000
1K 10T POT
C.W.
SERVO AMPLIFIER
SERVO MOTOR
L
6
C
100Ω SLIDE W.
U
2.2M
4.7K
10,100K STEPS
10K
1.5K
1.5K

FIG. 3. SCHEMATIC of signal amplifier (top right), separator and recorder (bottom) and power supply (top left).

a superposition of the 24-cps sample beam signal and the 48-cps reference beam signal. This is amplified by the preamp and then fed to the input of the two channels of the main amplifier for further amplification and separation of the two signals (Fig. 3). Separation of the signals is accomplished by the use of frequency-sensitive electric-network band-pass and band-reject filters. The 24-cps channel has a 24-cps reject filter (parallel-tee)** in the feedback loop of a 6SJ7, so the output will be 24-cps bandpass. The 48-cps component is further reduced by having a reject filter in series. The reject filters are hermetically-sealed units and are denoted in the electrical schematic by a square with the reject frequency marked on it.

The 48-cps channel is identical except that the position of the filters is reversed. The output stage of each channel is a cathode-follower with a transformer to match the low input impedance of the recorder. At the output of the amplifier we have an alternating 24-cps signal (which is a measure of the intensity of the sample beam) and an alternating 84-cps signal (a measure of the intensity of the reference beam). Before these signals can be ratioed electrically by the recorder, each must be converted to dc. This requires a synchronous rectifier for each frequency.

Usually a rectifier for this purpose is a cam-driven lever switch. The cam is mounted on the same shaft as the beam chopper to make the action synchronous with the light signal. This arrangement is subject to wear, leading to required maintenance. This analyzer uses rectifiers that have no sliding surfaces. Each rectifier consists of two sealed magnetically-operated glass switches (normally open) with a horseshoe magnet nearby to close them, and an iron vane which (when between a switch and magnet) acts as a magnetic shield and allows the switch to open. One of the four switches is shown in Fig. 2. Here also synchronous rectification is accomplished by mounting the iron vanes on the same shaft as the light-beam chopper. Phasing of the rectifiers is adjusted by rotation of the vanes with respect to the light-beam chopper while timing is adjusted by varying their angular width.

The full-wave rectified signals are filtered and fed into a measuring circuit in the recorder so that the recorder slidewire position, or pen position, is the ratio of the 24-cps sample beam intensity to the 48-cps reference beam intensity, or percent transmission. The recorder then can be calibrated to read directly in percent concentration of the sample. The 48-cps reference beam signal is put across the recorder slide wire through a lk, 10-turn, span-control resistor. A fraction of the changing (due to sample absorption) 24-cps sample beam signal is taken from a lk, 10-turn, scale-shifting potentiometer and balanced against the recorder slidewire.

Conclusion

This analyzer has more than sufficient sensitivity for this particular problem, is unusually versatile in that span-control and scale-shift adjustments are simply potentiometer settings, is adaptable to other problems and requires little maintenance.

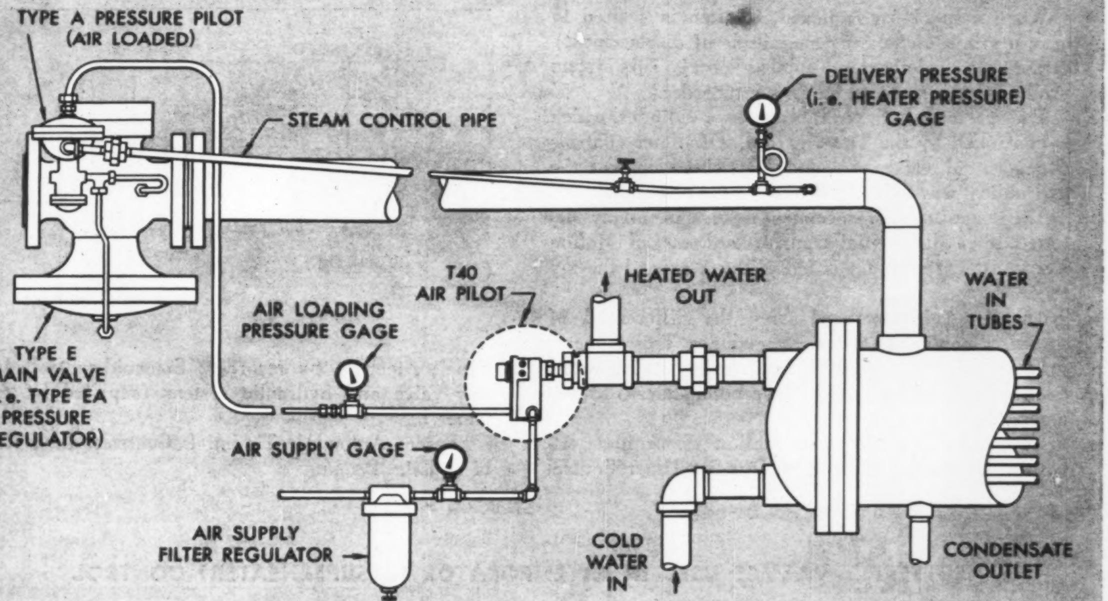
Acknowledgements

The author is particularly grateful for the contributions of H. D. Ruhl to the development of the electronic circuitry for this analyzer, and for the many helpful suggestions of L. W. Herscher.

TT Electronics, Inc. Culver City, California

CONTROL TIPS:

New Spence Temperature Control System with Cascade Control Accuracy at Regulator Costs


TYPE A PRESSURE PILOT (AIR LOADED)
STEAM CONTROL PIPE
DELIVERY PRESSURE (i.e. HEATER PRESSURE) GAGE
TYPE E MAIN VALVE (i.e. TYPE EA PRESSURE REGULATOR)
T40 AIR PILOT
HEATED WATER OUT
WATER IN TUBES
AIR LOADING PRESSURE GAGE
AIR SUPPLY GAGE
AIR SUPPLY FILTER REGULATOR
COLD WATER IN
CONDENSATE OUTLET

TYPE EAT40 AIR-CONTROL TEMPERATURE REGULATOR

In a recent installation the new Spence air-control temperature regulating system provided:

- ±5°F control accuracy under wide and instantaneous load swings of 210 to 80 gallons per minute.
- Up to 50% reduction in cost as compared to instrument systems of similar accuracy.

This unique cascade-type control with throttling range adjustment independent of maximum heater pressure was developed to meet today's demand for greater control accuracy.

Additional features of the new Spence Temperature Control System include:

- 200°F wide adjustable temperature range
- Adjustable speed of steam pressure change
- Over and under temperature protection
- Pressure limit control
- Fast response
- Very low air consumption
- Field reversible for heating or cooling

The Spence Type EAT Air Control Temperature System, when properly installed, will tame wide ranging, fast changing loads of instantaneous heaters and modern heat exchangers. The cascade principle plus the use of an extremely fast responding bi-metal temperature sensing element reduce time lags and provide control stability.

Here's how the new Spence system operates:

Quick response is based on a bi-metal temperature sensing element.

Temperature pilot continuously regulates a loading air pressure.

This loading signal, when applied to a pressure regulator to reflect heater temperatures, causes it to adjust the main valve as changes in load require.

Spence has also developed a new pressure control system based on this same cascade principle. This system has a control accuracy of ½ psi or better from positive pressures through the vacuum range to 30" Hg.

For complete information on these new air controlled temperature and pressure control systems, write for your copy of Bulletin 9.

SPENCE ENGINEERING COMPANY, INC.
Walden, New York

SE-148A

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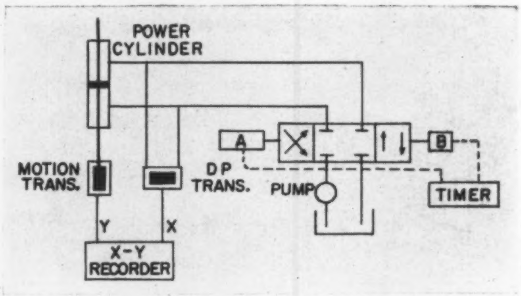
Process Control Systems

FRED D. MARTON, Instruments Publishing Company

FATIGUE TESTING SYSTEM RECORDS FLEXURE VS FORCE



When a specimen is flexed, it often is desired to have a graph of flexure (magnitude of displacement) versus rate of deflection (applied force). This system produces such a record on an x-y recorder.

The specimen is flexed by the power cylinder, which is controlled by the Timer shown. The timer controls two solenoid valves (A and B), which control the hydraulic 4-way valve for operating the power cylinder.

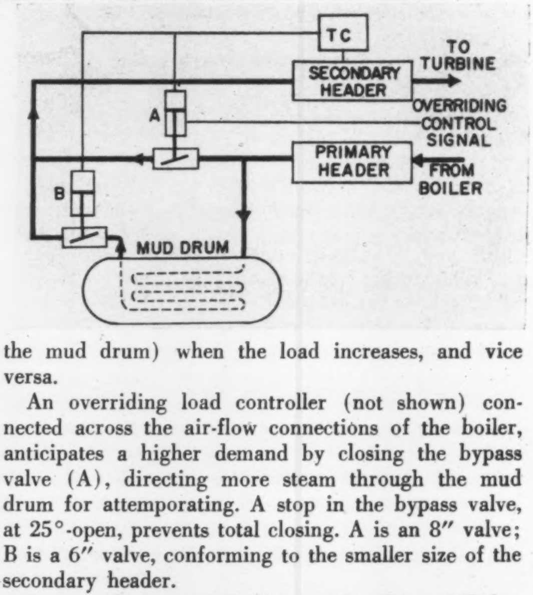
The magnitude of specimen flexure is simply detected by a differential transformer, marked Motion Transmitter. Its output is fed to the Y-axis of the x-y recorder.

The force is measured from the differential of pressures applied to the power cylinder. This is measured by a DP Transmitter, again using a differential transformer. One x-y recorder accommodates 5 testing machines.

Equipment used: Atcotran Motion Transmitter; Atcotran D-P Transmitter; ATC Duo-Set Timer Control Panel; Atcotran x-y recorder; Solenoid-controlled 4-way valve and hydraulic system (supplied by customer.)

Source: Automatic Timing & Controls, Inc., King of Prussia, Penna.

BUTTERFLY VALVES USED IN ATTEMPORATOR (DESUPERHEATER) CONTROL



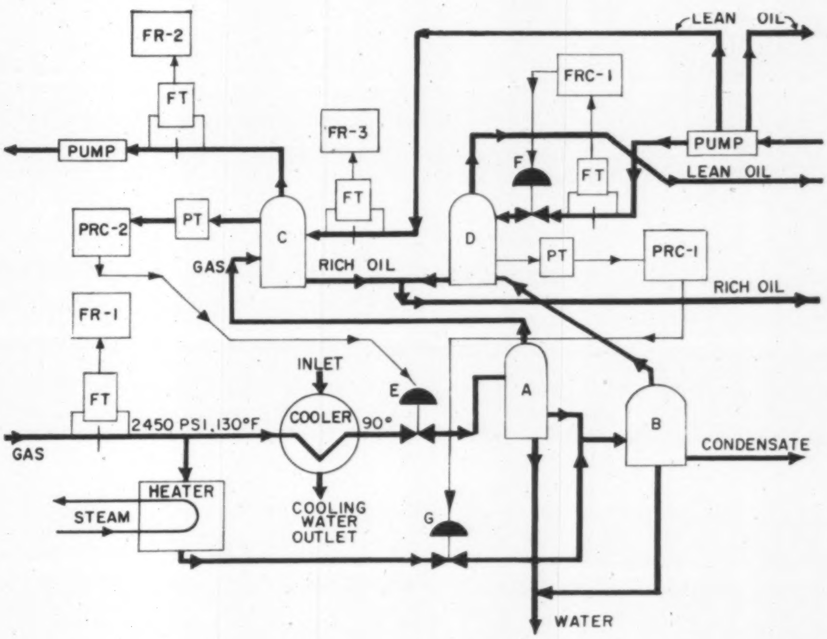
Attemporator (desuperheater) control, formerly an exclusive domain of plug-type valves, has, with increasing line sizes, become a field for application of butterfly valves. Butterfly valves offer several advantages: small face-to-face dimensions, low pressure-loss and high capacity, flow characteristics similar to equal-percentage plugs, low maintenance, and low cost. The system shown controls the temperature of steam to a turbine in order to safeguard the turbine buckets from erosion or metal fatigue due to excessive temperature fluctuation. Two butterfly valves are used—one in the secondary header leading from the mud drum to the steam turbine, and another in a bypass line between the primary and secondary headers.

At high turbine loads, the steam passes from the primary header through the mud drum. At low loads, it bypasses the drum and reaches the turbine directly. A temperature controller (TC) of simple design, having proportional mode of control only, located before the turbine inlet in the secondary header, determines the routing of the steam. Its split-range signal is piped to the cylinder actuators of both valves; it closes the reverse-acting valve A (in the bypass) while opening the direct-acting valve B (in the outlet from the mud drum) when the load increases, and vice versa.

An overriding load controller (not shown) connected across the air-flow connections of the boiler, anticipates a higher demand by closing the bypass valve (A), directing more steam through the mud drum for attemporating. A stop in the bypass valve, at 25°-open, prevents total closing. A is an 8″ valve; B is a 6″ valve, conforming to the smaller size of the secondary header.

Source: Continental Equipment Co., Div. of Fisher Governor Co., Coraopolis, Penna.

NATURAL GASOLINE PLANT SEPARATOR SEPARATES RAW STOCK INTO GAS, LEAN OIL AND RICH OIL



In the Separation, Absorption and Re-cycling Section of a refinery plant handling natural gas used as raw feed stock, the gas is first chilled, and the water and petroleum condensate removed in two *separators* (A and B).

Next, the less volatile hydrocarbons in the gas are removed in absorbers (C and D). A "lean oil" from farther along in the process (top right) is introduced into the top of the main absorber (C) and sales gas absorber (D) to flow counter-current to the gas, which is introduced at the bottom. The lean oil absorbs the less-volatile hydrocarbons but does not absorb the gas. In this process the oil becomes enriched and is drawn off as rich oil from the bottom of the absorber, from where it goes to the reabsorbers.

The gas in the absorption and condensate system, after removal of the hydrocarbons, is used (1) as fuel in the process itself, (2) part is sold to consumers as sales gas, and (3) the remainder (practically all methane) is pumped or recycled back into the earth through injection wells for storage and future use.

The raw stock reaches the plant at high pressure (2450 psig) and high temperature (130°F) and is first cooled in a cooler to 90°F before it reaches the high-pressure separator from which it leaves with a pressure of 1800 psig and temperature of 90°F. Control of the inlet valve (E) is exercised by a pressure controller (PRC-2) which senses the pressure in the main absorber.

Part of the main process stream goes through a heater (instead of to the cooler) and combines with the outflow from separator A; it then goes to the condensate system to be sold to the consumer. The temperature in the sales gas separator (B) is 95°F. From the top of the high pressure separator (A) the gas piped back to the injection wells for storage goes through the main gas absorber; likewise, from the top of the sales gas separator the surplus goes to the sales gas absorber where the less-volatile hydrocarbons are eliminated, as described.

Three valves control the system. One (valve E) controls flow of input raw stock. It is controlled by the pressure in the main absorber via PRC-2.

The second valve (G) controls the flow of heated input gas into the second (sales gas) separator. It is controlled from the pressure in the sales gas absorber via PRC-1. The third valve (F) controls flow of lean oil to the sales gas absorber directly via FRC-1.

Other instrumentation consists of three Type R112 flow recorders. FR-1 receives its primary signal from a d-p transmitter in the raw stock supply line; flow recorder FR-2 records the flow of gas to the gas injection wells; FR-3 records the flow of lean oil to the main absorber.

All three control valves are operated by Type 132 Electropneumatic valve positioner, and are single seated for tight shut off. Line sizes are small as the whole system works under pressures between 800 and 2450 psig. The three Microsen R112 recorders, the PRC's and the FRC (Type C-110) are all electronic instruments, as are the pressure transmitters (Type 145) and the differential-pressure transmitters (Type 154). The transmitters work on a force-balance principle. Output currents vary from 1.0 to 5.0 ma dc, linearly proportional to input pressure or flow.

All controllers have proportional plus reset action.

Source: Manning, Maxwell & Moore, Inc., Stratford, Conn.; also Application Bulletin 6.1.

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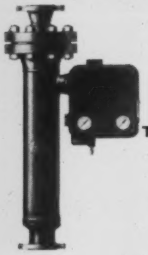
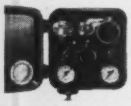
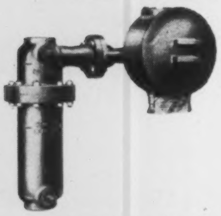
Wherever Industry Requires



TYPE 2500-259B



TYPE 2502-259B

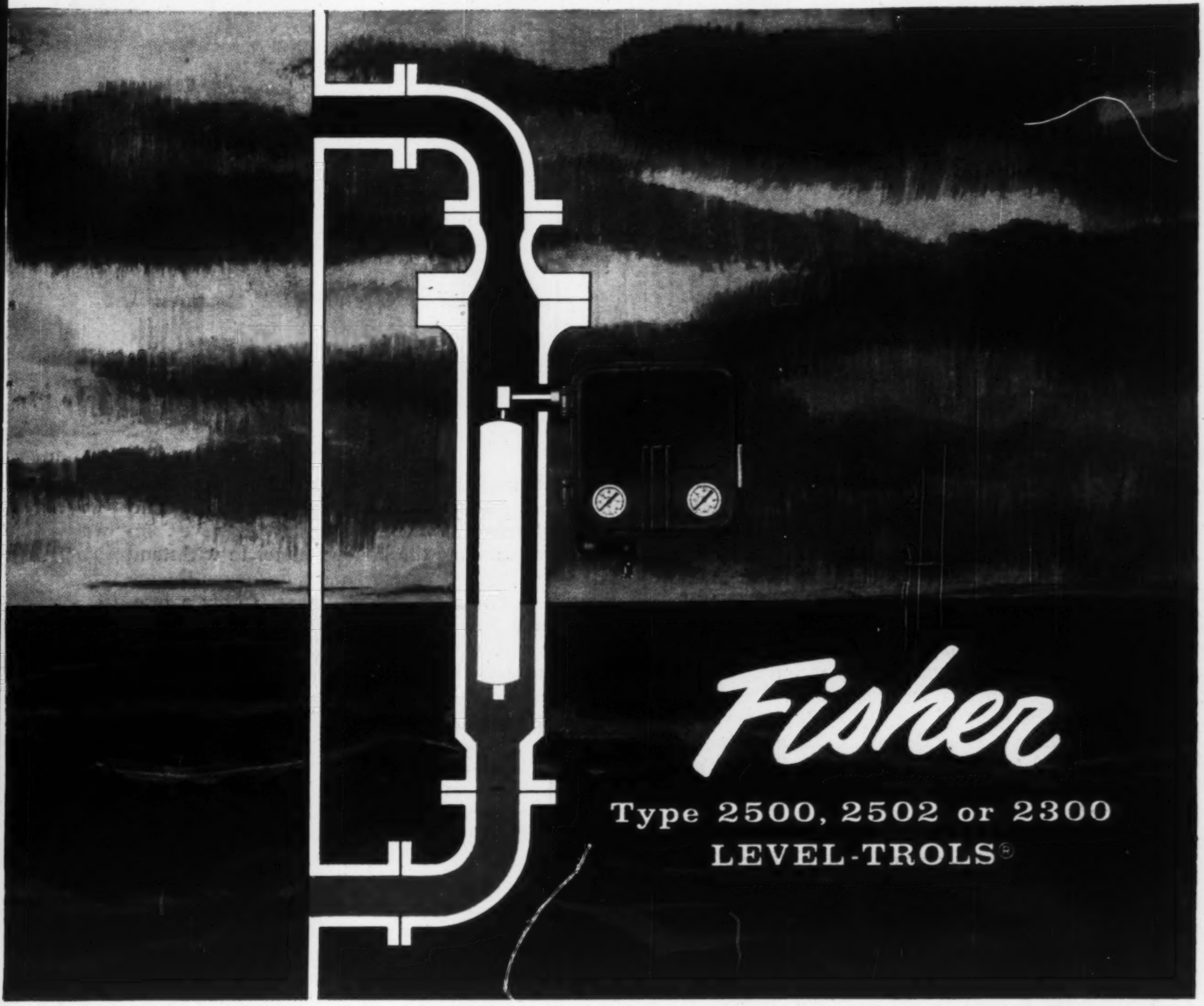


TYPE 2300-249

FISHER PROVIDES 3 BASIC LEVEL-TROLS

Fisher Level-Trols operate on the displacement float principle. This, in conjunction with a torsional spring or "torque tube" transmits level changes to the pilot, and provides the simplest and most effective means yet discovered for accurately and continuously measuring liquid level or specific gravity.

The basic simplicity of the design makes the operation of these controllers virtually friction free and accounts for the great popularity they have achieved throughout the industrial world; particularly in the process and power industries.



Dependable Liquid Level Control

THE POPULAR TYPE 2500 PROPORTIONAL CONTROLLER

A compact and economical liquid level controller, the Type 2500, provides a proportional band adjustment up to 100%. It is pneumatically operated and level position is manually adjustable for quick and simple selection of set point. The 2500 is suitable for 3 to 15 psi or 6 to 30 psi output ranges and the action of the controller can be easily reversed in the field. It mounts on all standard Fisher Level-Trol float cages.

TYPE 2502 PROPORTIONAL CONTROLLER WITH RESET

This controller is the most complete single unit liquid level controller available today. It includes, in the same size case, all the features of the Type 2500, plus reset action. It therefore, automatically, brings the set point back to its original position and assures absolutely stable control. Reset rate is adjustable from .005 to 1 minute per repeat.

TYPE 2300 ELECTRONIC LEVEL-TROL

Explosion-proof design and external adjustments for proportional band and liquid level set point, make the Fisher Electronic Level-Trol ideal for use in hazardous locations. Available for output DC signals 1 to 5 ma, 4 to 20 ma or 10 to 50 ma. Has plug-in converter with printed circuit.

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CIRCLE 30 ON READER-SERVICE CARD

JOURNAL OF THE SOUTHERN CALIFORNIA METER ASSOCIATION

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BELLOWS-TYPE

AN ORIFICE METER measures the differential pressure produced across a restriction placed in a flow line. One measurement technique balances the differential pressure against a column of mercury in a U-shaped tube, as in the conventional mercury-type meter; the other technique balances the differential pressure with a bellows and calibrated springs (Fig. 1).

A modern bellows-type orifice meter comprises a center plate with a bellows mounted on each side of it. The ends of the bellows are connected by a solid stem passing through an angular hole in the center plate. The interior of the bellows and center plate are completely filled with a liquid and then sealed. This constitutes a frictionless piston, free to move from one side to the other as pressure is applied to the outside of the bellows. Pressure applied to the exterior of bellows causes its volume to decrease; liquid is moved to the opposite bellows, which increases in volume. This results in a linear movement along the axis of the bellows. The motion, proportional to the differential pressure applied, is picked up by a drive arm connected to a torque tube.

The *torque tube* transmits the motion to pointer or pen arm or other indicating or recording device. The tube requires no lubricant or packing and offers a positive seal against pressure; no leaks are possible. It has a certain amount of preload so there is no backlash as the meter travels from full-range to full over-range. As the drive arm and the torque tube are located on the interior of the bellows and center plate assembly and never come in contact with the measured fluid, corrosive fluids have no effect on the meter.

THE NINTH ANNUAL INSTRUMENT SHORT COURSE will be presented Tuesday, April 12, and Wednesday, April 13, 1960, at the Los Angeles Harbor College. As in the past, the Southern California Meter Association is co-sponsoring this event with the cooperation of its members. For exhibit information: Maynard Strader, Chairman, Exhibits Committee, 9th Annual Instrument Short Course, Southern California Meter Association, Union Oil Co. of Calif., P. O. Box 758, Wilmington, Calif.

A real "bug" in early bellows meters, as well as in the conventional mercury meter, was the damaging effect of over-range. Today, however, internal valves allow the bellows meter to withstand full line pressure against one side, even though the differential range of the meter is only a fraction of the line pressure. For example, if we use a meter with a range of 20″ W.C. on a line with static pressure of 4500 psi, the full 4500 psi can be impressed on either the high- or low-pressure side, with the other side open to atmosphere. The meter will not be damaged, nor will there be change in calibration or shift of zero.

This protection is achieved by mounting valve seats as an integral part of the high- and low-pressure side of the center plate around the annular opening, as shown in Fig. 1. The center stem passing through the annular hole has a special valve with O-ring seats mounted on both the high- and low-pressure side and so positioned to allow for back-travel, full calibrated movement, and overtravel. As the valve stem moves through its calibrated travel into an over-range position, the O-ring valve on the stem seats against the valve seat on the center plate, preventing additional transfer of the non-compressible fill liquid. Once the valve is closed the bellows on the higher-pressure side is under no differential because the pressure of the liquid inside will be the same as the pressure exerted outside.

Ambient Temperature Compensation

The meter should not be sensitive to variations in ambient temperature due to thermal expansion and contraction of the fill liquid. This temperature compensation is achieved by mounting a secondary bellows on the extreme end of the high-pressure bellows. This extra bellows is connected through a passage in the inner cup of the high-pressure bellows to the balance of the system, but is not connected to the center stem. It is free to change volume as the fill fluid expands and contracts. As the action of this compensator bellows in no way affects the main bellows and connecting

ORIFICE METERS

W. S. CHRISTIAN
Barton Instrument Corporation

stem, calibration is not affected. Tests show that the bellows unit for this type of meter has a temperature drift of only 0.2 to 0.4% per 100°F change in ambient temperature. This compares with approximately 3% shift in calibration in the conventional mercury-type manometer for the same temperature change.

Range Springs

Both the bellows and the torque tube act as a spring and, if used alone, would calibrate to about 18″ W.C. In order to obtain the popular differential ranges used in flow measurement (20″, 25″, 50″, 100″ and up to 400″), additional spring loading of the bellows unit is necessary. This is done by adding a spring to the outside of the low-pressure bellows. The springs are always under tension and increase tension as the meter goes upscale. They are made up in integral assemblies marked with the ranges they produce and thus it is economical and easy to change ranges. Range springs are made of Iso-Elastic material.

Damping

When used where pulsation is present, the bellows flowmeter can be furnished with an internally adjustable pulsation damper. The full-scale response can be changed from about 2 seconds (undamped) to 4 or 5 minutes (damped).

This damping action is accomplished by placing a free-floating restriction on the stem near the annular hole in the center plate. Also, a needle valve is placed in the by-pass for the fill liquid. As the needle valve is adjustable from the outside while the meter is in service, proper damping can be achieved quickly when pulsation presents measurement problems. When the needle valve is wide-open (undamped), the response rate is about 2 seconds. The restriction ring which causes the liquid to by-pass is free floating and the instru-

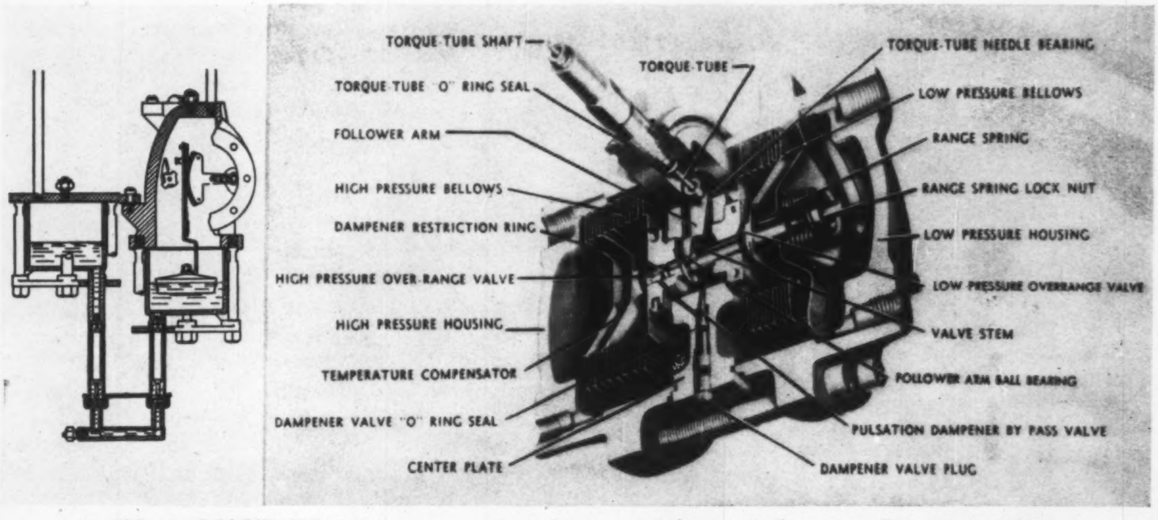
TORQUE-TUBE SHAFT
TORQUE-TUBE "O" RING SEAL
FOLLOWER ARM
HIGH PRESSURE BELLOWS
DAMPENER RESTRICTION RING
HIGH PRESSURE OVER-RANGE VALVE
HIGH PRESSURE HOUSING
TEMPERATURE COMPENSATOR
DAMPENER VALVE "O" RING SEAL
CENTER PLATE
TORQUE-TUBE
TORQUE-TUBE NEEDLE BEARING
LOW PRESSURE BELLOWS
RANGE SPRING
RANGE SPRING LOCK NUT
LOW PRESSURE HOUSING
LOW PRESSURE OVERRANGE VALVE
VALVE STEM
FOLLOWER ARM BALL BEARING
PULSATION DAMPENER BY PASS VALVE
DAMPENER VALVE PLUG

FIG. 1. CONVENTIONAL manometer-type flowmeter (left) and bellows-type flowmeter (right).

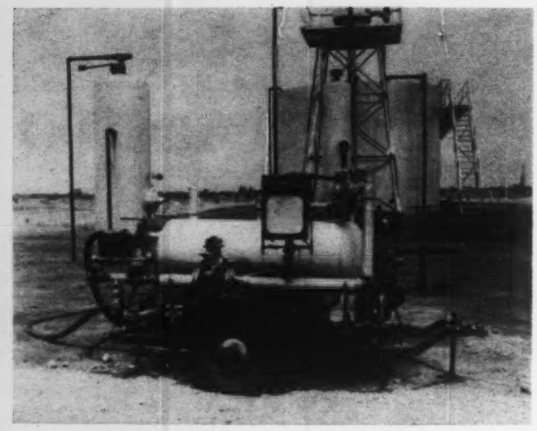

FIG. 2. **BELLOWS-TYPE** flow recorder on portable well tester.

ment will remain "alive" even though the needle valve is closed completely. This eliminates the possibility of errors that could occur should the damper be accidently closed completely.

Housings are fitted with pipe connections at the highest and lowest point on either side, thus making the instrument both self-draining and self-venting, depending on the type of service.

Bellows are of special design and feature long life and linear characteristics. The fluid being measured contacts only the inside of the housing and the outside of the stainless-steel bellows and does not come in contact with any parts that affect calibration.

Applications

Bellows-type flowmeters are being used in thousands of conventional flowmetering situations, but the following uses show how the special features of this flowmeter are put to work in unusual flowmetering problems. These features include (1) ability to be over-ranged, (2) stainless-steel and mercury-free construction, (3) self-draining and self-venting feature, (4) no need for "leg of liquid" correction, (5) ability to handle high-pressure fluids, (6) relative insensitivity to vibration and pulsation effects (as both high- and low-pressure bellows have same areas, there is little tendency to "pump up" when standing waves are present; also, as the bellows meter has low inertia, it can follow rapid flow variations without over- or under-shooting).

Valve qualification tests often require measurement and correlation between flow rate, pressure drop and valve opening. The differential pressure must be measured across the valve as the valve is traversed from full open to full shut and back again. The importance of the over-range feature can be appreciated when one considers a system wherein the static pressure is at 4500 psi. With the control valve being tested full open the pressure drop across it may be only a few inches of water. As the valve is closed the pressure drop increases and may reach 200″ W.C. when the valve is just off its seat. A fraction of a second later the valve seats and full 4500-psi differential is imposed across the meter. Before the advent of the bellows meter, this type of test procedure was practically impossible.

In the *food and beverage industry* the measurement of flow rate with a bellows-type meter with its stainless-steel construction and its lack of mercury or contaminates cannot be over-emphasized. In this industry we are not only dealing with the obvious limitations placed on it by the Pure Food & Drug Act but must also be cognizant of the more subtle considerations such as taste and color.

Measurement of flow rate through filters in a *water-treatment plant* used on swimming pools is a matter of public health. Many states and counties have set up minimum standards of filtration. Therefore, it is common practice to measure either the flow through the filters or the pressure drop across the filters. Here again, freedom from contamination by the measuring device is a factor in selecting the bellows-type meter. Many local bodies governing public health either have outlawed or discouraged the use of mercury, and also the use of instruments employing glass bodies.

Many common process-plant fluids such as ammonia, SO_2, H_2S, caustics, acids, etc., now can be measured safely by using bellows-type flowmeters.

High pressure can have two undesirable effects on conventional meters—leakage and friction caused by heavy loads on the thrust bearings make maintenance a problem and often necessitate venting of the case when inflammable or toxic fluids are being measured. The torque tube incorporated in the bellows meter is immune to these problems and venting is unnecessary.

The conventional manometer's accuracy depends on a constant relation between the relative cross-section areas of the high-pressure and low-pressure chambers as well as the constant relationship between the float and the meniscus of the mercury. High pressure can change both of these relationships and affect accuracy. Also, when measuring liquids with a manometer type of instrument, or when using a liquid seal to protect the manometer against corrosive gases, a correction must be made for the leg of liquid over the mercury. When measuring gases at high pressure, the effect of the displaced leg or gas with its greatly increased density can have a serious effect. For example, in measuring natural gas at a pressure of 3000 psia, the error introduced by the density effect alone is approximately 1.6% of the total differential range. In the bellows-type meter the differential pressure is not balanced by a leg of liquid; therefore, these corrections are unnecessary.

In many processing plants, ambient temperature changes widely. The superiority of the temperature compensation inherent in the bellows-type meter cannot be over-emphasized.

The design of the bellows-type meter permits the use of various fill liquids in the bellows corresponding to the temperature conditions that will prevail in the fields where they are used. The standard fill consists of a stabilized 50-50 mixture of ethylene glycol and distilled water and is suitable for operating temperatures from approximately —60° F to 200° F with short-term peak temperatures up to 225° F maximum. If the meters are for use in areas such as Montana, Wyoming and Canada where extremely low temperatures are commonly encountered, they may be filled with varying mixtures of alcohol and water enabling them to operate in temperatures as low as —90° F.

Of interest in areas where wet gas is produced is the bellows-type meter's ability to cope with condensate and oil carry-over conditions. The conventional meter forms a natural trap for condensable liquids because connections to the high- and low-pressure sides are located at the top. A build-up of condensate tends to increase or decrease the recorded differential. In fields where condensate is a problem the meters must be checked for zero at frequent intervals and, if a shift has taken place, the instrument must be dismantled and cleaned. Operators have gone to great extremes to provide meters with condensate chambers and accessory equipment in order to protect them. This, however, adds to the initial expense and still requires vigilance on the part of the operator.

In the bellows-type meter, condensate and oil carry-over represent no measurement or maintenance problem. Both the high- and low-pressure housings are fabricated with pressure connections at both the highest and lowest point, and thus do not form traps. When measuring condensable gases, or when faced with oil carry-over problems, these meters are mounted above the flow line with the impulse lines from the orifice assembly sloping up to the bottom connections. If condensation or oil carry-over takes place, it simply drains back in the line. If gas with viscose crude "slugs" is being measured, the pressure housings can be rotated so that the connections are located at the bottom, providing larger area openings and more effective draining.

If periodic cleaning is desired, the pressure housings may be simply flushed with a solvent without removing them from the meter body, since each is supplied with two connections. Even under the worst conditions, where sand has entered the meter body and becomes caked on the bellows in the presence of heavy oil, the heads need only to be removed and the bellows washed with cleaning solvent and a soft brush.

Salt water will attack the housing, pivots, and links of conventional flowmeters, and will usually carry with it sufficient sand and pipe scale to cause a build-up of foreign material on the high-pressure side of the meter, affecting calibration. Bellows-type meters, with their sealed type-316 stainless-steel construction, are immune to the effects of salt water.

Common practice dictates that meters used in measuring liquids should be placed below the flow line, so that the advantages of self-venting can be incorporated. However, this sometimes presents practical problems in bleeding the lines, especially when a system is subject to frequent shut-downs. Although bellows meters may be installed in this way, they are readily adapted to installation above the flow line with the impulse lines sloping up to the bottom connections. In this type of installation, vent valves are frequently installed in the upper connections, thus providing a rapid means of pressure bleeding. This type of installation is not possible with conventional meter because over-range would result when one of the vent valves is "cracked." Installation of a meter in this fashion, while not following recommended practice, does solve some practical problems.

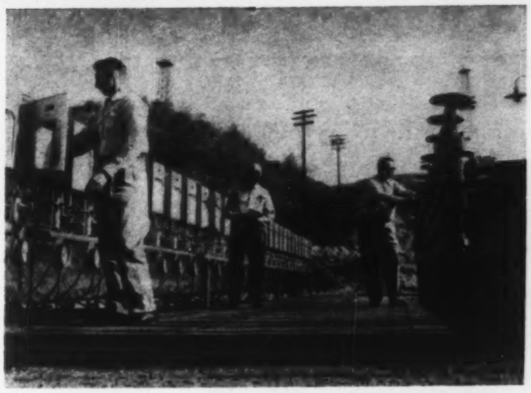

FIG. 3. BELLOWS-TYPE flow recorders in water flood service. Salt water, gas or LPG is injected to increase oil recovery.

Nowhere is precision of measurement more sought after than in the *gas utility field*. Current practices are concerned with accuracies in the neighborhood of ¼%. With demands of this sort, the comparisons for variations due to temperature and pressure between bellows-type meters and their mercury-actuated counterpart cannot be overlooked. In gas utilities, as in process plants, installation cost often can be cut due to the fact that no leakage exists and case venting is unnecessary.

The Economics of Flow Measurement

The cost of flow measurement can be listed as follows:

1. Cost of meter.

2. Cost of installation, including piping, manifolds, protective device, etc.

3. Cost of a maintenance program to insure sustained accuracy.

4. Cost of product or loss occurred when measurement errors exist.

The cost of bellows-type meters is normally a little higher than the mercury type. However, the rising cost of mercury has reduced this difference. The additional cost of drip pots, condensing reservoirs, leveling saddles and complex piping and valving necessary in mercury-type installations often gives the bellow-type meter an economic advantage.

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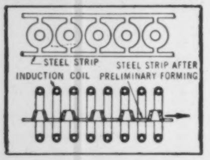
TYPICAL INDUCTION HEATING APPLICATIONS

PLASTIC COATING OF TOOL HANDLES

A production line operation for coating handles of tools at Whitney Metal Tool Co., Rockford, Ill. uses induction heating with excellent results. The handles only are heated by induction to the desired temperature then dipped into a vinyl chloride base coating material for a short period depending upon the thickness of coating desired. The plastic coating formed on the handles is then cured by immersion in a carbo-wax bath.

FORMING OF METAL STRIP FACILITATED BY PROGRESSIVE ANNEALING



Metal forming operations which require intermediate anneals to restore ductility can be facilitated by induction annealing the strip progressively. Diagram illustrates this procedure for partially formed thin austenitic stainless steel strip. The induction annealing operation is scheduled in the production line between two press operations. Metal strip and wire of other materials are also induction annealed in this manner.

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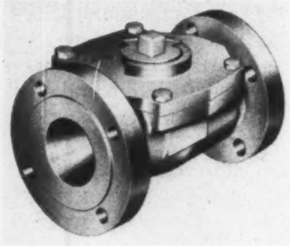
ICS NEW INSTRUMENTS

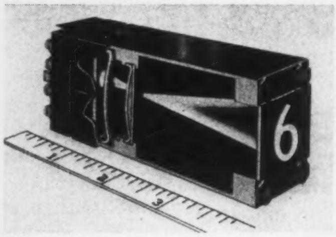
BALL VALVES



New series Flo-Ball valves, Series 711, features the ball rotating on a fixed axis between bearings that require no lubrication (thus being able to absorb tremendous impacts and loading without backlash or danger of distortion); replaceable seats; balanced design; self-aligning and self-adjusting characteristics for controlled seat loading and positive sealing.—*Hydromatics, Inc., 70 Okner Parkway, Livingston, N. J.*

CIRCLE 190 ON READER-SERVICE CARD

MINI DIGITAL READOUT



New Miniaturized Digital Readout, Series 120000, for digital camputers, etc. operates on rear-projection principle. When one of the twelve subminiature lamps at the rear of the unit is lighted, the lamp projects the corresponding digit on the condensing lens through a projection lens onto the viewing screen at the front of the unit. Character size is ⅝".—*Industrial Electronic Engineers, Inc., 5528 Vineland Ave., North Hollywood, Calif.*

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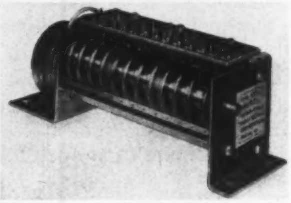
PROGRAM TIMER FOR GSE



New HYS Repeat Cycle Timer measuring 2¼" x 2¼" x 7" contains 12 SPDT, independently-adjustable load switches. Motor rating is 115 v, 60 cps. Time cycle is 90 sec. Built for ground support equipment, it withstands vibration of 0.060" double-amplitude displacement from 5 to 55 cps and shock of 30 G's for 11 msec.—*Eagle Signal Co., Moline, Ill.*

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PROFILE MONITOR

New Profile Monitor, Model 201, provides an accurate, easily interpreted, visual display of any phenomena measurable by an electrical output. Typically monitored are temperature, pressure, strain, and velocity. With accommodations for as many as 90 inputs it can display one of these phenomena, or any combination having comparable electrical outputs. Details in Data Sheet PM2-917. —*Advanced Technology Labs., Div. of American-Standard, 369 Whisman Rd., Mountain View, Calif.*

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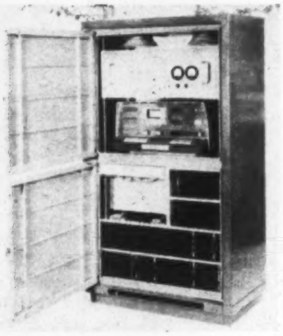
FOR FURTHER INFORMATION USE THE FREE ORDER CARD ON PAGE 515

COMPUTER CONTROL SYSTEM

New fully-transistorized LN-3000 Digital Computer, developed under a joint agreement between Leeds & Northrup and Philco, is intended primarily for use in on-line data reduction systems and process control systems. However, it is suitable, without modification, for off-line uses. Depending upon the particular application, a system incorporating the LN-3000 may perform any one of the following three general functions: (1) on-line data reduction and calculation of operating guides, (2) program control, and (3) supervisory computer control. To meet the requirements of these functions, the LN-3000 was designed as a general-purpose, serial, internal-binary, fixed-point, stored program computer with the following characteristics: Address Structure—single address or 1 & 1 as determined by the programmer. Order Structure—16 basic orders, including square root, which may be modified to provide over 60 operations. Computing Times—Add or Subtract—0.91 msec. Multiply, Divide, or Square Root—3.6 msec. Shift—0.91-3.6 msec. Word Length—20 bits + sign + parity. Main Memory—magnetic drum, 8000 or 16,000 words. Rapid Access—4 words standard. Arithmetic Register—three transistorized registers including the accumulator, two of which may be used as additional rapid-access storage. Other considerations that strongly influenced the design were reliability and fail-safe performance. All logic circuits are built around one basic diode-transistor module. All circuits are conservatively rated, and manufacturing techniques were carefully selected. Error detection and correction techniques are incorporated through programming and logical design. The computer is able to monitor itself and the input-output equipment for random errors and component failures. In addition, all system outputs which control process operation have non-volatile memory to provide for fail-safe performance. The system may also be arranged to perform essential alarm monitoring functions even when its more complex sections are removed from operation.—*Leeds & Northrup Co.,* 4910 *Stenton Ave., Phila.* 44, *Pa.*



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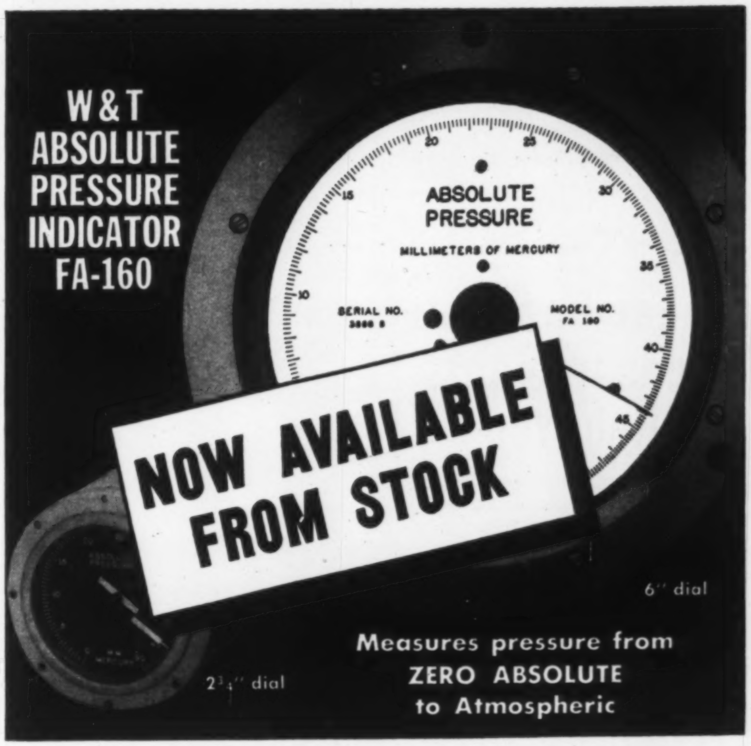

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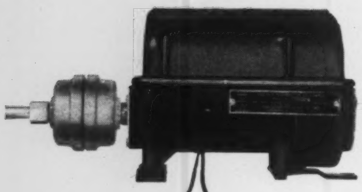
PRESSURE INDICATOR—CIRCLE 74
VOLUMETRIC FEEDERS—CIRCLE 161



Let Speed Measurements Help You

Let the Esterline-Angus Speed Recorder System provide you with records that will help you

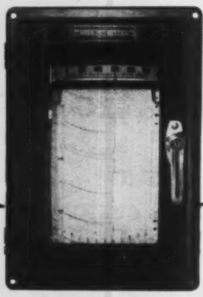
- **determine production rates,**
- **control product quality,**
- **check performance of equipment and machinery,**
- **establish operator efficiency and safety.**

All you do is connect the shaft of the E/A Tachometer Generator (above) to any equipment whose speed you want to measure.

The Tachometer Generator actuates an E/A strip-chart Speed Recorder (below) giving you an accurate, permanent, indisputable record.

There's no end to the applications of the E/A Speed Recorder. For instance, in continuous manufacturing operations, such as paper and steel production and annealing and baking processes. They're also used for such things as measuring lost time, the flow of liquids or gases, and in time studies on machinery which is stopped and started between operations.

You'll find many other applications described in Bulletin 260. Ask for a copy or for an E/A specialist to call.



The Esterline-Angus Company

No. 1 in fine Graphic Instruments for more than 50 years.

Dept. G, P.O. Box 596, INDIANAPOLIS 6, IND.

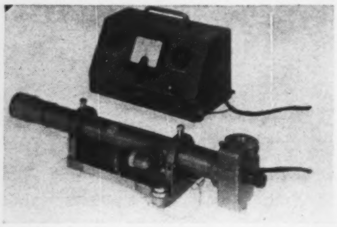
CIRCLE 83 ON READER-SERVICE CARD

FREQUENCY COUNTER

New Electronic Counter, Model 521G, automatically measures frequency and random events per unit of time or (with the manual gate feature) totalizes electrical events. With transducers, it also provides convenient measurements of such mechanical quantities as speed, rpm, rps, weight, pressure, temperature and acceleration. Frequency range is 1 cps to 1.2 mc. Accuracy is ±1 count ± the accuracy of power line frequency—usually ±0.1%.—*Hewlett-Packard Co.*, 275 *Page Mill Rd., Palo Alto, Calif.*

CIRCLE 195 ON READER-SERVICE CARD

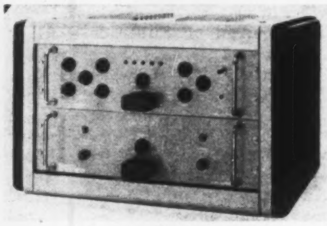
AUTO-COLLIMATOR



New Microptic Auto-Collimator reading to 0.1 sec of arc has now a photoelectric system that eliminates the need for repeated observation through the eyepiece when making exact settings, in the checking of gears, dividing heads, rotary tables, circular spacing generally—or where reference mirrors are used to test stability, repetition, expansion or other delicate mechanical movements.—*Engis Equipment Co.*, 431 *S. Dearborn St., Chicago* 5, *Ill.*

CIRCLE 196 ON READER-SERVICE CARD

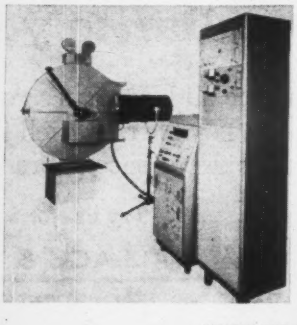
D/A CONVERTERS



New EI 4700 Series Dataverters translate digital data from punched cards, punched paper tape, and magnetic tape into analog voltages to operate EI X-Y plotters, and also generate control signals for both the input devices and the X-Y plotter. Output features include scaling, output multiplier, and symbol generation. Circuitry is completely transistorized with both magnetic core and transistor logic being used.—*Electro Instruments, Inc.*, 3540 *Aero Court, San Diego* 11, *Calif.*

CIRCLE 197 ON READER-SERVICE CARD

ULTRA SPEED CAMERA



New Ultra Speed Camera can take from 480 to 1,600,000 pictures/sec on standard 35-mm film, in black-and-white or color, by using an electro-optical shutter which controls passage of light by means of ultra-rapid electric pulses. One or two optical lenses focus the image onto a rotating mirror in the film box. The film remains stationary while the mirror revolves at the rate of 100,000 rpm. The special pulser system designed for this camera permits effective exposure times of 0.05 to 1.0 μsec.—*Benson-Lehner Corp.*, 1860 *Franklin St., Santa Monica, Calif.*

CIRCLE 198 ON READER-SERVICE CARD

basic tool for process measurements . . .

FOXBORO
IN
OUT

FOXBORO d/p CELL* TRANSMITTERS

Positive overrange protection . . . no perceptible zero drift . . . high sustained accuracy, even under the most punishing operating conditions.

D/p Cell bodies are available in 316 s.s. or rustproofed carbon steel. Unique stainless steel twin-diaphragm capsule is specifically designed to provide positive overrange protection. Purged cover protects transmitter from weather, dust, and fumes.

You can install d/p Cells anywhere — in any position — simply and conveniently, and know they'll give unequaled accuracy and performance. Ask your Foxboro Field Engineer for complete details, or write for Bulletin 13-11A. **The Foxboro Company, 463 Neponset Avenue, Foxboro, Mass.**

Foxboro d/p Cells for flow, liquid level, and other variables

- for high-speed flow measurement and control
- for flow measurement as small as 0.03 gpm
- for flow under static pressures to 6000 psi
- for use where elevated or suppressed ranges are required
- for electronic flow control systems
- for liquid level
- for comparison of process and sample fluids
- for absolute pressure measurement

**Reg. U. S. Pat. Off.*

Three fully adjustable ranges:
0-5 to 0-25 inches of water
0.20 to 0-250 inches of water
0-200 to 0-850 inches of water
Working pressures of 500, 1500, and 6000 psi

FOXBORO
REG. U.S. PAT. OFF.

CIRCLE 84 ON READER-SERVICE CARD

VARIAN
Potentiometer
RECORDERS

Something important
has been added . . .

5. THE NEW G-22 IS

2 CHANNEL

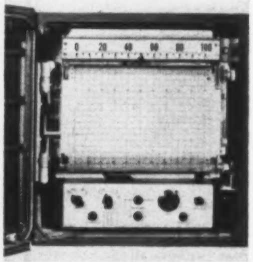
Two channels mean more than just an added trace. They make the G-22 a correlator of simultaneous variables—any pair you choose. And among two-channel recorders, the G-22 is the most practical yet—lighter, more compact, more versatile and lower in cost than any other of its type.

Interchangeable plug-in input chassis; 1% limit of error and one second full-scale balancing time; adjustable range from 0-10 mv to 0-100 mv; dual chart speed standard; four speeds optional; portable or panel-mount versions; weight 35 pounds; price $975. Full specifications available. Write the Instrument Division.

VARIAN
associates
PALO ALTO 27, CALIFORNIA

CIRCLE 85 ON READER-SERVICE CARD

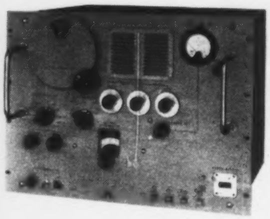
DYNAMASTER LAB RECORDER



New Laboratory Model of the Dynamaster Potentiometer Recorder lends itself-readily to measuring pressure, temperature, motion, flow, density, pH, and electric power. A four-position input selector switch provides for mv, v, μamp, or ma input. A five-position span selector offers ranges 0-2, 0-5, 0-10, 0-25, and 0-50. Several attachments are offered.—*Bristol Co., Waterbury* 20, *Conn.*

CIRCLE 199 ON READER-SERVICE CARD

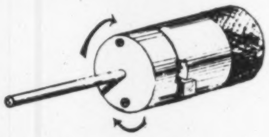
X-BAND SIGNAL GENERATOR



New DY-5381 Signal Generator which delivers a minimum power output of 250 mw over the range from 8,500 to 10,000 mc, with outputs up to 400 mw in the vicinity of 9,500 mc, features a continuously-operating power monitor which permits power setting repeatability within ±0.5 db over a wide ambient temperature range.—*Dymec, Div. of Hewlett-Packard Co.,* 395 *Page Mill Rd., Palo Alto, Calif.*

CIRCLE 200 ON READER-SERVICE CARD

SHEATH STRIPPING TOOL



New tool for sheath removal from metal-sheathed, ceramic-insulated thermocouple wires affords operation as simple as sharpening a pencil. Pamphlet gives details.—*Equipment Sales Co.,* 150 *East Hillside Rd., Barrington, Ill.*

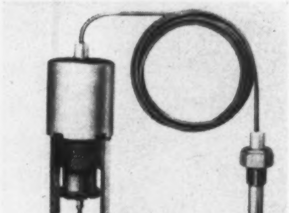
CIRCLE 201 ON READER-SERVICE CARD

LOGIC ELEMENTS

New line of encapsulated Logic Elements for 100-kc operation are for portable, mobile and airborne equipment as well as missile systems.—*C & K Components, Inc.,* 103 *Morse St., Newton* 58, *Mass.*

CIRCLE 202 ON READER-SERVICE CARD

TEMPERATURE REGULATOR



New self-powered Temperature Regulator, especially designed for use on gas-fired petroleum heaters and treaters, has a Buna "N" disc, assuring bubble-tight closure. A polished stainless steel valve stem and "O"-ring stem seal made of Buna "N" provide smooth, leak-free valve operation. A stem cleaner or wiper is provided to protect the "O"-ring seal. Valve sizes are ½" and ¾". Temperature range is 110-190°F.—*Fulton Sylphon Div., Robertshaw-Fulton Controls Co., Box* 400, *Knoxville* 1, *Tenn.*

CIRCLE 203 ON READER-SERVICE CARD

DIGITAL READOUT 'SCOPE

New high-frequency, general-purpose Oscilloscope, Model 425, which features the first direct digital reading system in an oscilloscope of modular construction, includes a series of interchangeable plug-in amplifiers, and a new cathode-ray tube. The digital readout of time (in μsec and msec) and amplitude (to 3 places) which appears on the front panel of the instrument is accomplished through the manipulation of two measuring dots on the face of the scope which are moved by joy stick controls and thumb wheels so that they are aligned with the waveform presentation being studied. For remote analog devices such as computers and recorders, an analog voltage proportional to the digital reading may be taken out of the 'scope directly. The five basic modules include the distributed amplifier, the low-voltage power supply, the high-voltage power supply, the X-chassis and sweep circuits, and the front panel which incorporates the readout generator, sync circuits, cathode-ray tube, and general framework. Through two, 40-pin connector plugs at the top of the chassis, the scope may be tied in directly with external data processing equipment including punch cards and printers. The new cathode-ray tube, especially designed for the Model 425, offers extreme sensitivity, high light output, fine resolution, and an acceleration potential of 12,000 v. Frequency range is from dc to 60 Mc (down 3 db at 35 Mc). Accuracy is 2%. System virtually eliminates all possibility of human error in interpolation, parallax adjustment and computation.—*Allen B. Du Mont Labs., Inc., 750 Bloomfield Ave., Clifton, N. J.*

CIRCLE 204 ON READER-SERVICE CARD

AIR AND GAS DRYERS

New completely, self-contained Molecu-Dryers permit high-temperature drying to dew points of −100°F or better using Linde's Molecular Sieves. Reactivation is by conducted heat in dessicant bed with cooling cycle accelerated by same medium. No inert gas purging for reactivation is needed.—*C. I. Hayes, Inc., Wellington Ave., Cranston* 10, *R. I.*

CIRCLE 205 ON READER-SERVICE CARD

a rare degree of
PLEROPHORY

VOLTRON
VOLTAGE
INDICATOR

VOLTRIP
VOLTAGE
COMPARATOR

IN
GO/NO-GO
VOLTAGE MEASUREMENTS

accuracy: DC 0.25%, AC 0.5%

Built-in voltage reference.
Externally programmable with series resistors.

environmental: MIL-M-6A; MIL-M-10304A; MIL-E-5272

Send for literature and name of local representative.

VOLTRON *products*

1020 So. Arroyo Parkway
Pasadena, California

CIRCLE 86 ON READER-SERVICE CARD

ACCURACY IN PRESSURE MEASUREMENT

begins with CEC's 6-201 Primary Pressure Standard

For solutions to pressure measurement problems, depend on the experience and know-how of Consolidated Electrodynamics—the only single source for all your pressure instrumentation needs. The integrated CEC line ranges from rugged transducers, readout, and other related precision equipment to primary calibration instruments.

Accuracy begins with CEC's 6-201 Primary Pressure Standard, a calibration instrument used to ensure the accuracy of pressure measurement devices.

This pneumatic dead-weight piston gage offers a resolution of better than 0.005% of reading... covers six pressure ranges from 1.5 to 500 psi, with a minimum pressure of 0.3. It assures accuracy that is conservatively rated at 0.015% of full scale in pressure ranges to 150 psi and at 0.025% of full scale in pressure ranges of 150 to 500 psi.

The 6-201 is a true primary standard that utilizes mass, length and time for its references. Its accuracy depends only upon the dimensional accuracy of its component parts. *Write for Bulletin CEC 1581-X24 for detailed specifications.*

For complete information on CEC pressure instrumentation and pressure measurement devices, write today for Bulletin CEC 1308-X14.

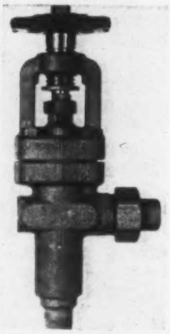
Transducer Division CEC

CONSOLIDATED ELECTRODYNAMICS / pasadena, california

A SUBSIDIARY OF Bell & Howell • FINER PRODUCTS THROUGH IMAGINATION

ALL-PURPOSE ANGLE VALVE

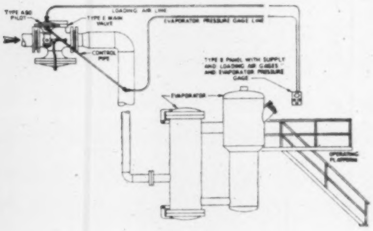
New Angle Valve, No. 74, serves as a basic liquid-level-gage valve; with the addition of a special pipe plug with integral bleed fitting it becomes Instrument Valve No. 74G. OS&Y bolted bonnet uses a forged yoke and a reciprocating backseating stem.—*Jerguson Gage & Valve Co.,* 80 *Adams St., Burlington, Mass.*



CIRCLE 206 ON READER-SERVICE CARD

AIR-LOADED REGULATORS

New remote-adjusted, air-loaded Presure Regulators maintain control accuracy to within ± ⅛ psi. Accurate regulation in the vacuum range coupled with temperature pilot control provides full modulation of heater input. Picture shows milk evaporator steam supply.—*Spence Engineering Co., Inc., Walden, N. Y.*


TYPE A50 PILOT
TYPE E MAIN VALVE
LOADING AIR LINE
EVAPORATOR PRESSURE GAGE LINE
CONTROL PIPE
TYPE B PANEL WITH SUPPLY AND LOADING AIR GAGES AND EVAPORATOR PRESSURE GAGE
EVAPORATOR
OPERATING PLATFORM

CIRCLE 207 ON READER-SERVICE CARD

TRANSISTORIZED P/S

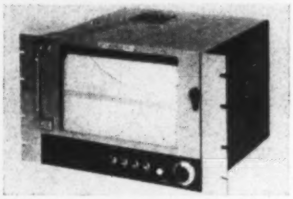
New voltage-regulated D-C Power Supplies, Model HB, feature regulation of 0.1% for line and load (0.01% provided on special order); wide, variable output range (0-325 vdc); output current of 200 ma, 400 ma, 600 ma (Models HB-2, HB-4, HB-6, respectively); ripple of 3 mv rms; and two 6.5-vac outputs at 6 amp each. Bulletin HB 59-10 gives details. —*Kepco Labs., Inc.,* 131-38 *Sanford Ave., Flushing* 55, *N. Y.*

CIRCLE 208 ON READER-SERVICE CARD

← CIRCLE 87 ON READER-SERVICE CARD

STRIP CHART RECORDER

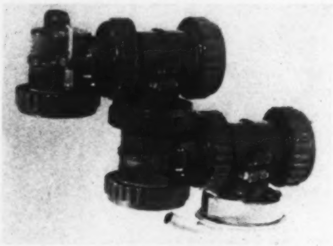
New Autograf Strip-chart Recorder, Model 80A, which provides instant selection of six chart speeds through transistor switching, has a full scale sensitivity of 0.05% and a resolution and accuracy of 0.2%. Chart speeds of 2, 4, 6, 8, 15, and 60"/min are selected instantly by front panel push buttons. Input range is 5 mv to 100 v. Pen speeds are to 0.25 sec full scale. Standard 120' chart rolls are used.—*F. L. Mosely Co., 409 N. Fair Oaks Ave., Pasadena, Calif.*



CIRCLE 209 ON READER-SERVICE CARD

AIR SAMPLER

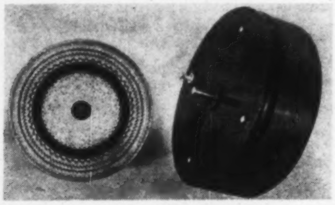
New Casella Cascade Impactor employs four jets in series to collect airborne particulates in the range of ½ μ to 200 μ. By employing low air velocities large-size dust samples can be collected without error.—*Mine Safety Appliances Co., 201 N. Braddock St., Pittsburgh 8, Pa.*



CIRCLE 210 ON READER-SERVICE CARD

SHAFT POSITION ENCODER

New Binary Coded Decimal Shaft Position Encoder, ADC-ST3-BCD, an an/dig converter, provides three decimal digits in binary-coded decimal for each revolution of input shaft. Other models of the Norden 1,000-count family of encoders include a 10,000-count/10-turn encoder, a 100,000-count/100-turn encoder, and a 1,000,000-count/1000-turn encoder.—*Norden Div., United Aircraft Corp., Wiley St., Milford, Conn.*



CIRCLE 211 ON READER-SERVICE CARD

CIRCLE 88 ON READER-SERVICE CARD⟶

VERSATILITY IN PRESSURE MEASUREMENT

with CEC's advanced line of precise sensing devices

From the only single source for all your pressure instrumentation needs... three new sensing devices that are typical of CEC advancements designed to solve problems in measurement and control applications:

4-332 MINIATURE PRECISION PRESSURE BALANCE

Less sensitive to acceleration and vibration . . . more stable than larger pressure balances—that's the record of this miniature device that's easier to use in wind tunnel pressure measurement and control applications. This device can be held in your hand . . . measures a scant 4" x 3" x 2½". CEC also offers pressure balances in high speed and standard models. *For complete information, write for Bulletin CEC 1547-X6.*

4-326 STRAIN GAGE PRESSURE TRANSDUCER

In such demanding applications as rocket test stands, this small but rugged transducer measures high-frequency gage or absolute pressures to 10,000 psi. It stands up to severe acoustical noise... maintains low acceleration response... is extremely stable at 1,000 g's at temperatures from −320°F to +300°F. The 4-326 is just one of 13 types of CEC transducers. *For details on this finest achievement in strain gage transducers, write for Bulletin CEC 1620-X10.*

4-380A LOW PRESSURE POTENTIOMETER

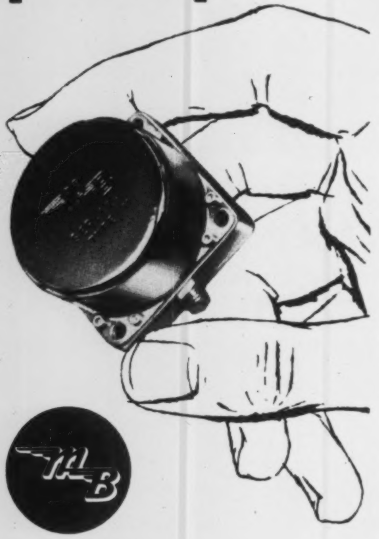
Put this pot to work in your toughest environment—it takes 25 g, 2 KC vibrations for hours, with negligible change in calibration. The 4-380A covers a pressure range of ±1 psi to 100 psi. When operated over most pressure ranges at −65°F to +200°F, it shows a temperature effect of less than 1%. Choose from absolute, gage and differential models. CEC high pressure pots are also available. *For specifications, write for Bulletin CEC 1604-X3.*

Transducer Division **CEC**

CONSOLIDATED ELECTRODYNAMICS / pasadena, california

A SUBSIDIARY OF **Bell & Howell** • *FINER PRODUCTS THROUGH IMAGINATION*

Advanced design in a vibration pickup



VIBRAMITE

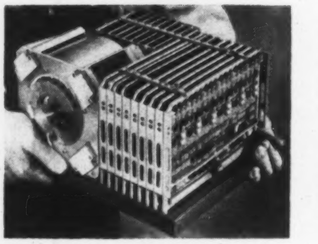
New MB velocity-type pickup features all these performance advantages:

- Miniature—only 1.42" square x 1" high
- Weighs only 2.75 oz —accurate signals
- Eddy current damped—stable sensitivity
- Flat response from 30 to 2000 cps
- Takes 50g acceleration continuous — impact to 1000g
- Continuous −85° to +500°F range
- Omnidirectional — no adjusting

Bulletin #112 tells more. Write . . .

MB ELECTRONICS
A DIVISION OF TEXTRON ELECTRONICS, INC.
1103 State Street, New Haven 11, Conn.
CIRCLE 89 ON READER-SERVICE CARD

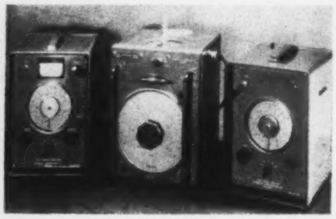
COMPUTER MISSILE GUIDANCE



New miniaturized Digital Computer for the Centaur guidance system accepts inputs from the inertial platform, performs the necessary guidance computations, and provides steering signals to the Centaur control system. Silicon-transistorized throughout, it is immune to a wide range of environmental extremes.—*Librascope, Inc., Glendale, Calif.*

CIRCLE 212 ON READER-SERVICE CARD

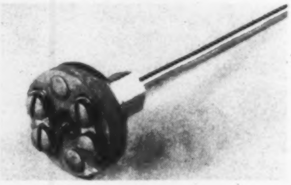
VHF ADMITTANCE BRIDGE



New VHF Bridge Model 978 uses a miniature thermistor element working in a servo feedback system as a conductance standard. This novel approach guarantees measurement accuracy of 2% to 300 Mc. Capacitance and conductance range is ± 40μμF and 0-50 millimhos (Illustrated are: Admittance Bridge, Bridge Source, and Detector.)—*Marconi Instruments,* 111 *Cedar Lane, Englewood, N. J.*

CIRCLE 213 ON READER-SERVICE CARD

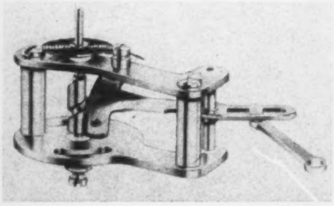
DIRECT COLD JUNCTION



New Cold Junction of the directly-connected type utilizes screw terminals for electrical connections. The hot junction may be of the exposed, closed-and-grounded, or closed-and-ungrounded type. A wide choice of standard process connections is available.—*Trinity Equipment Corp., Cortland, N. Y.*

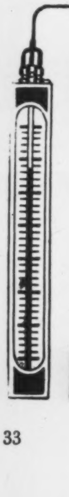
CIRCLE 214 ON READER-SERVICE CARD

TEFLON BUSHED GAGE MOVEMENT



New Pressure Gage Movement includes Teflon bushings which provide low static and kinetic friction and promote compressive strength and increased resistance to cold flow. Unaffected by outdoor weathering and having zero water absorption, they can also be used over a temperature range of −65°F to +300°F.—*Helicoid Gage Div., American Chain & Cable Co., Inc., Bridgeport 2, Conn.*

CIRCLE 215 ON READER-SERVICE CARD



TANK-O-METER
FOR MEASURING TANK CONTENTS
ANY DISTANCE AWAY

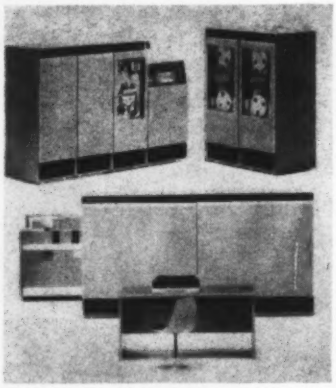
TANK MAY BE BURIED, ELEVATED, OPEN, CLOSED, VENTED OR UNDER PRESSURE OR VACUUM
SEND FOR BULLETINS

Also gauges for:
Barometric Pressure (Mercury Column)
Absolute Pressure (Mercury Column)
Pressure and Vacuum
Differential Pressure
Inclined Manometers for draft, pressure or differential pressure.

UEHLING INSTRUMENT CO. 470 GETTY AVE., PATERSON, N. J
CIRCLE 90 ON READER-SERVICE CARD

NEWEST COMPUTER—G-20

New G-20 system, solid-state large-scale computer, features fast and efficient computing at minimum cost. Addition rates of 45,000 or more operations per second are achieved; floating point circuitry is standard.



User is given choice of data precision, virtually unlimited indexing facilities, and convenient command structure. Basic 4096-word core memory can be expanded to 32,768 words of memory.

An algebraic compiler and a symbolic assembly routine make for simplified programming. Accessory assignment, program translation and problem scheduling can be done effectively within the Central Processor, relieving the operator of these tasks. Only a simple control console is required. Remote sub-systems provide great flexibility. Important feature: control buffer permits program-controlled on-line or off-line communications.

Up to 70 accessories may be connected to the G-20 input-output communication line, and several may be in use at the same time on a time-shared basis. This small yet powerful system "costs no more than others that are only 1/100th as fast."—*Bendix Computer Div.*, 5630 *Arbor Vitae St., Los Angeles* 45, *Calif.*

CIRCLE 216 ON READER-SERVICE CARD

ACCELEROMETERS

New line of self-generating accelerometers, featuring 500°F operation and less than 3% lateral sensitivity for missile and aircraft vibration testing and for general industrial applications, has a first resonent frequency of 50kc and 1600 $\mu\mu$fd internal capacity. Maximum acceleration is 5000 G's. Ratings of standard models are 5 mu/g, 10 mu/g, and 20 mu/g sensitivity.—*Clevite Electronic Components*, 3405 *Perkins Ave., Cleveland* 14, *Ohio.*

CIRCLE 217 ON READER-SERVICE CARD

E Pluribus Unum

A New Strain Gage Differential Pressure Transducer Combining Features Never Before Available in One Instrument.

1. Single diaphragm design for **direct differential pressure measurement.**
2. All-Weld 303 & 347 Stainless Steel construction.
3. Corrosive and conductive media can be applied to both the reference and high pressure ports.
4. Small physical size and high natural frequency.

PRESSURE RANGES

MODEL PT69

Shown approximately FULL SIZE
Weight — 17ounces

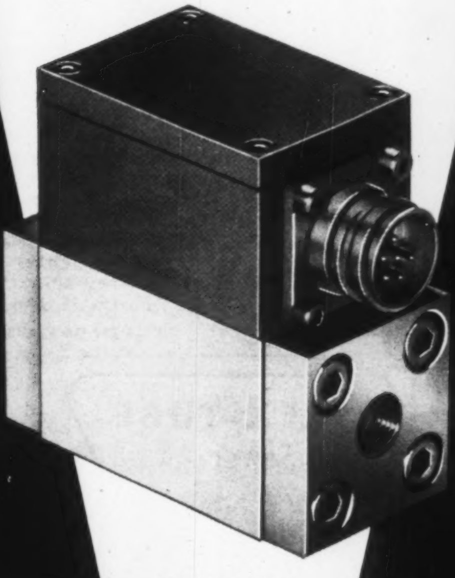
HIGH LINE PRESSURE

DYNISCO
HIGH ACCURACY

Dynisco

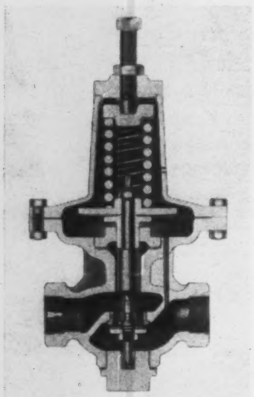
For further information on this transducer and details on our complete product line, write to DYNISCO INC., attention Sales Department
42 Carleton Street, Cambridge 42 Massachusetts

CIRCLE 91 ON READER-SERVICE CARD



PRESSURE REGULATOR

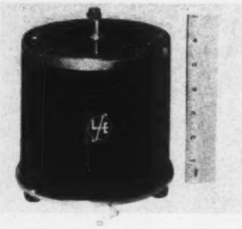
New Hi-Flo Pressure Regulators, classes WLK, WK, WHK, WL-2, W-2, WH-2, WLB, WB and WHB are designed for inlet pressures from 10-300 psig and temperatures up to 180°F. Reduced ranges available cover pressures from 5-100 psi. They are said to offer 50% to 100% greater capacity than other comparable regulators. Features include large bowl construction and long travel diaphragm, fully balanced operation, tight shutoff, etc.—*Leslie Co., 122 Delafield Ave., Lyndhurst, N. J.*



CIRCLE 218 ON READER-SERVICE CARD

MAGNETIC DISK MEMORY

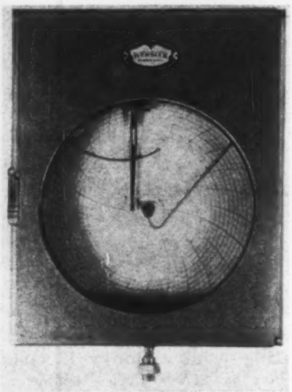
New LFE Bernoulli-Disk which utilizes, in part, principles of fluid motion derived from the conservation of energy in liquids and gases consists of a flexible Mylar magnetc disk that is rotated close to a smooth stabilizing backplate in which read/write heads are imbedded. When at rest, the limp disk falls away from the backplate; but in motion, the limp disk becomes flattened by centrifugal force and the disk pumps air through the orifice and out at the disk periphery. The hydrodynamic forces of the air between the disk and the stabilizing plate together with the dynamic and elastic forces of the revolving disk, cause the disk to conform to the backplate at a controllable and small separation. Advantages claimed are reliability, shock-resistance, low power requirements.—*Lab for Electronics, Inc., 1079 Commonwealth Ave., Boston 15, Mass.*



CIRCLE 219 ON READER-SERVICE CARD

RECORDING INSTRUMENTS

New line of Temperature, Pressure, and Humidity Recorders is available in 8″ chart size with one to three pen systems; in 10″ or 12″ chart sizes with one to four pen systems; in hand-wound or electric chart drives for 12-hr, 24-hr, 7-day, and 31-day revolution. Temperature recorders are mercury-, liquid-, gas-, or vapor-actuated; pressure recorders contain specially heat-treated spiral-wound bronze, beryllium copper, alloy or s.-s. bourdon tubes; humidity recorders are of two types.—*Weksler Instrument Corp., 195 East Merrick Rd., Freeport, L.I., N. Y.*



CIRCLE 220 ON READER-SERVICE CARD

NEW Dwyer FLEX-TUBE Series 25

THE MANOMETER THAT

- COSTS HALF as much
- Is only HALF as BIG
- IS ACCURATE to 3%
- Does 4 NEEDED JOBS

and is practically indestructible!

Only 7⅜″ wide, 5⅞″ high and 1 3/32″ deep. Housing and tube of tough Tenite II plastic. Logarithmic indicating tube for accurate and easy reading. Two ranges: 0-3″ and 0-7″. Gages (1) static pressure, (2) draft, (3) filter resistance and (4) velocity from 0-7000 fpm. (with pitot tube).

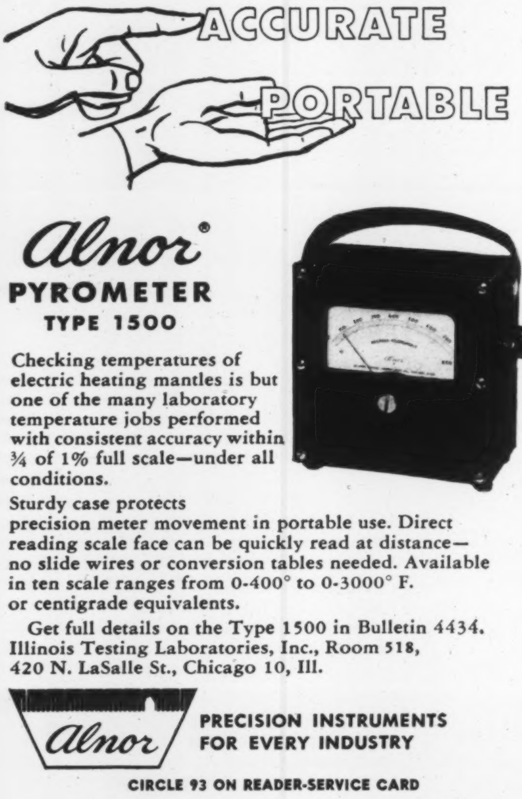
A complete "package." Unit includes all necessary connector tubing and fittings, mounting screws, fluid, instructions.

Write for informative catalog page

F. W. DWYER MFG. CO.

P. O. BOX 373—S MICHIGAN CITY, INDIANA

CIRCLE 92 ON READER-SERVICE CARD



ACCURATE PORTABLE

Alnor® PYROMETER TYPE 1500

Checking temperatures of electric heating mantles is but one of the many laboratory temperature jobs performed with consistent accuracy within ¾ of 1% full scale—under all conditions.

Sturdy case protects precision meter movement in portable use. Direct reading scale face can be quickly read at distance—no slide wires or conversion tables needed. Available in ten scale ranges from 0-400° to 0-3000° F. or centigrade equivalents.

Get full details on the Type 1500 in Bulletin 4434. Illinois Testing Laboratories, Inc., Room 518, 420 N. LaSalle St., Chicago 10, Ill.

Alnor PRECISION INSTRUMENTS FOR EVERY INDUSTRY

CIRCLE 93 ON READER-SERVICE CARD

CRESCENT ARMORED MULTITUBE®

IMPROVED CABLED TUBING

gives you a better job at less cost

for use with INSTRUMENTS and PROCESS CONTROL EQUIPMENT

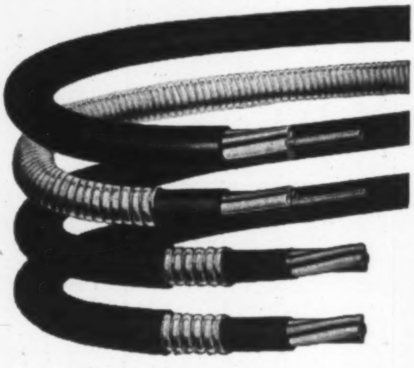
Carries Air, Gas or Fluid

CRESCENT ARMORED MULTITUBE is a group of 2 to 37 tubes of copper, aluminum, steel or polyethylene **spirally cabled together** and protected by a flexible, interlocked galvanized steel armor, or by a tough corrosion resistant thermoplastic sheath, or a combination of both (see below).

The SPIRAL CABLING of the tubes permits easy bending to a small radius without distortion of the tubes. It can be installed with great saving in time.

Special constructions are available for underground runs. This product is licensed under U. S. Patent 2,578,280.

CRESCENT ARMORED MULTITUBE completely out-dates the old method of using single tubes, with users reporting *savings in installed cost of* from two to five times the cost of the multitube. In addition, the MULTITUBE system will result in fewer connections and fittings, lower costs for supports or racks, ease of mounting and less space.



FOUR CORROSION-RESISTANT TYPES

A plastic jacket of polyvinyl chloride over SPIRALLY CABLED copper or aluminum instrument tubing provides complete moisture and corrosion protection for the tubes. Flexible galvanized steel armor in various combinations, as shown, gives maximum protection for permanence. Available in size 1/4" O.D. in lengths to 1000 feet in from 2 to 37 tubes.

Plastic Coated Single Tubes, copper or aluminum, should be used to give corrosion protection to all single lines up to the final tube fitting, where trouble from corrosion may occur.

SEND FOR BULLETIN 458-A GIVING COMPLETE INFORMATION AND ENGINEERING DATA

CRESCENT INSULATED WIRE & CABLE CO.

Trenton 5, New Jersey

CIRCLE 94 ON READER-SERVICE CARD

New pressure controls . . . 0.5 to 150 psig.

Diaphragm Pressure Regulators

. . . with PLUS-PERFORMANCE FEATURES

Now . . . Robertshaw engineers answer still more of your pressure control problems with these highly efficient diaphragm-actuated companions to our famous *bellows* self-ops!

Ruggedly built and modestly priced, this new 1065 Series is offered in four diaphragm sizes, with nine different ranges from 0.5 to 150 psig. Single-seated ½″ to 2″ valves for positive shut-off . . . piston-balanced in the larger sizes; double-seated, 2½″ to 4″ sizes.

- **Nylon-reinforced, moulded Buna-N diaphragm**
- **Spring-loaded Teflon chevron lifetime packing**
- **Ball-bearing wheel adjustment**
- **Quick-disconnect, polished monel valve stem**
- **Stainless steel trim standard**
- **Highest quality chrome steel adjusting spring**
- **Valve designs backed by years of field service**

For complete specifications, ask for Bulletin EL-125 **Fulton Sylphon Division, Robertshaw-Fulton Controls Company, Knoxville 1, Tennessee.**

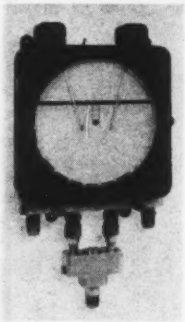
Robertshaw

MR. CONTROLS

CIRCLE 95 ON READER-SERVICE CARD

GAS FLOW RECORDER

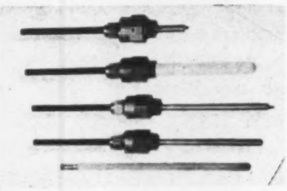
New Dual Gas Flow Recorder for argon, helium, oxygen, CO_2, etc. simultaneously measures and records flow of 2 identical or different gases in range from 15 lpm to 3000 cfh; and input pressures from 20 to 200 psig. Has 10″ chart, and indicator lights to show which side is used.—*Elematic Equipment Corp.*, 6731 *South Chicago Ave., Chicago* 37, *Ill.*



CIRCLE 221 ON READER-SERVICE CARD

HI-TEMP & PRESS T/C PROBE

New Thermocouple Probe measures liquid and gas temperatures in the 1800°F range at pressures in excess of 2000 psig. Available in various standards lengths, it includes s.-s. sheathed models and either covered or exposed probes for use with hot gases, and ceramic sheaths for liquid metals and acids. Constructed of chromel-alumel or chromel-constantan with ⅝″-18NF mounting thread standard.—*Technical Industries Corp.*, 389 *North Fair Oaks Ave., Pasadena, Calif.*



CIRCLE 222 ON READER-SERVICE CARD

pH-CONTROL PROPORTIONING PUMPS

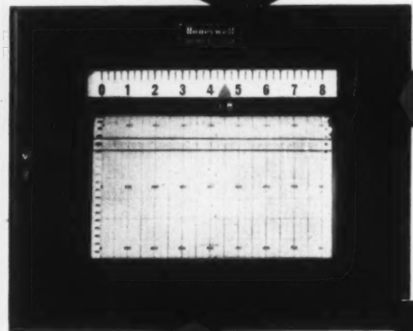
New pneumatically-operated Automatic pH-Control Feeder Proportioning Pump for automatic pH control of process water in industry responds to standard pneumatic control pressures of 3 to 15 psig and accurately feeds chemicals in proportion to the varying hydrogen-ion concentration. In addition, a dual-control feature enables it to feed chemicals in proportion to a varying flow rate.—*B-I-F Industries, Inc.*, 345 *Harris Ave., Providence* 1, *R. I.*

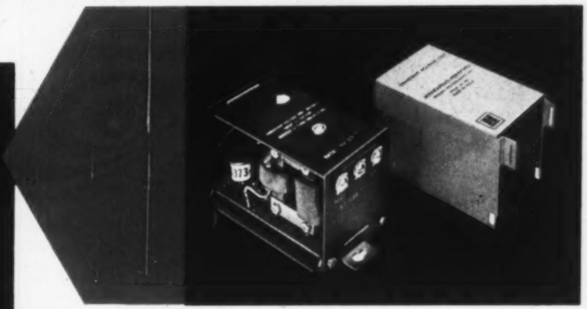
CIRCLE 223 ON READER-SERVICE CARD

CIRCLE 345 ON READER-SERVICE CARD →

MODULAR DESIGN MAKES 1960 *Electronik* POTENTIOMETERS A GREATER VALUE THAN EVER

BALANCING AND CHART DRIVE MOTORS are sectionalized. Service is simplified because any major part can be replaced in a matter of seconds.





CONSTANT VOLTAGE UNIT* eliminates need for batteries, standard cells, and standardizing mechanisms . . . insuring long life.

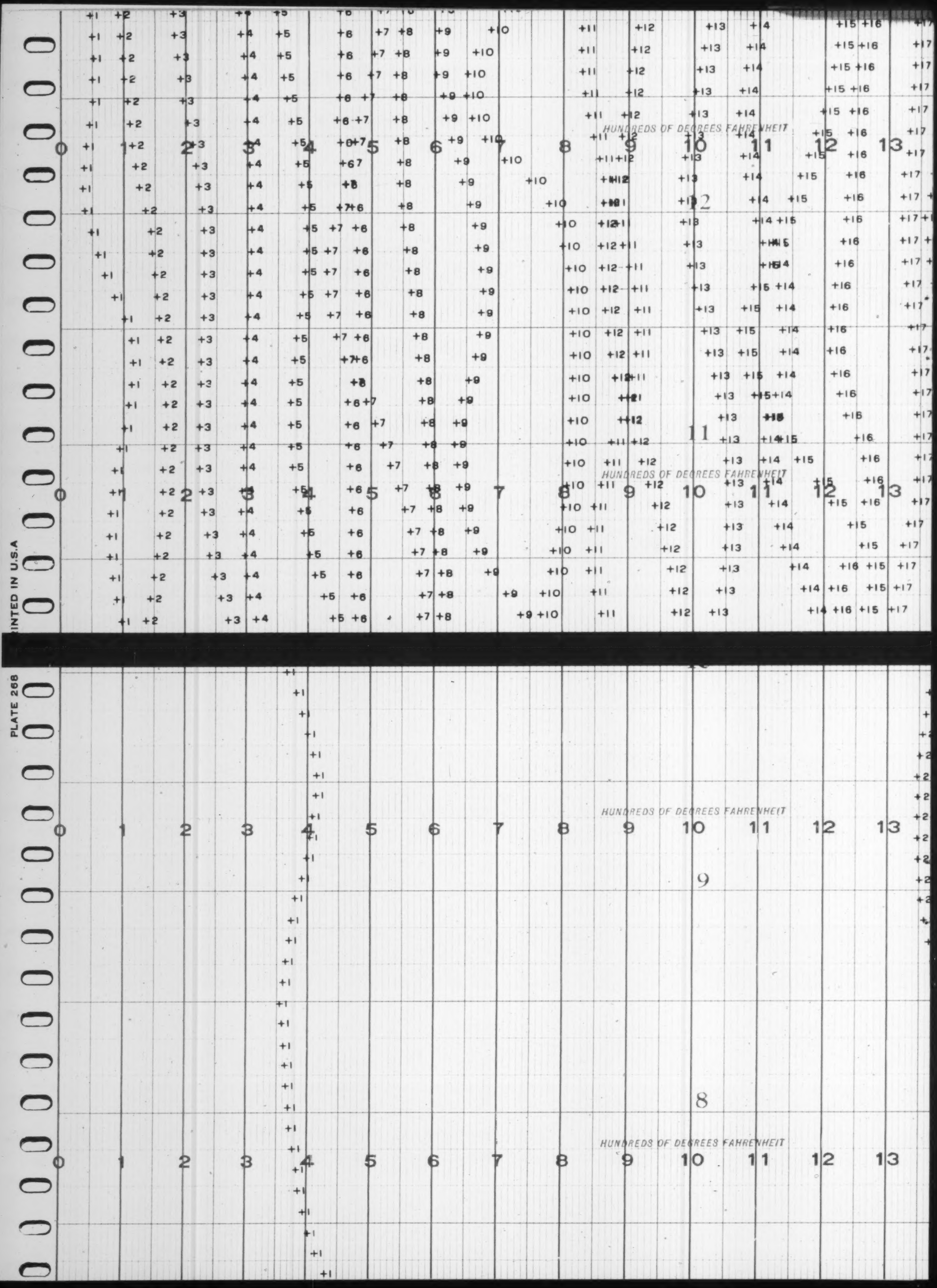
*Zener Diode

COMPARTMENTED MEASURING CIRCUIT UNIT makes range changing easy. Change one screw on a clip connected card of fixed resistors, and the job is done in a matter of seconds.

BROWN
Electronik

QUICK-CONNECT AMPLIFIER is easily removed from the instrument by means of a polarized plug.

BUT THIS IS JUST PART OF THE STORY OF THE 1960 LINE OF ELECTRONIK POTENTIOMETERS.
LOOK AT THE DRASTIC CHANGES IN THE ELECTRONIK MULTI-RECORD RECORDERS.


PRINTED IN U.S.A
PLATE 268
HUNDREDS OF DEGREES FAHRENHEIT
0 1 2 3 4 5 6 7 8 9 10 11 12 13
12
HUNDREDS OF DEGREES FAHRENHEIT
0 1 2 3 4 5 6 7 8 9 10 11 12 13
11
HUNDREDS OF DEGREES FAHRENHEIT
0 1 2 3 4 5 6 7 8 9 10 11 12 13
9
8
HUNDREDS OF DEGREES FAHRENHEIT
0 1 2 3 4 5 6 7 8 9 10 11 12 13
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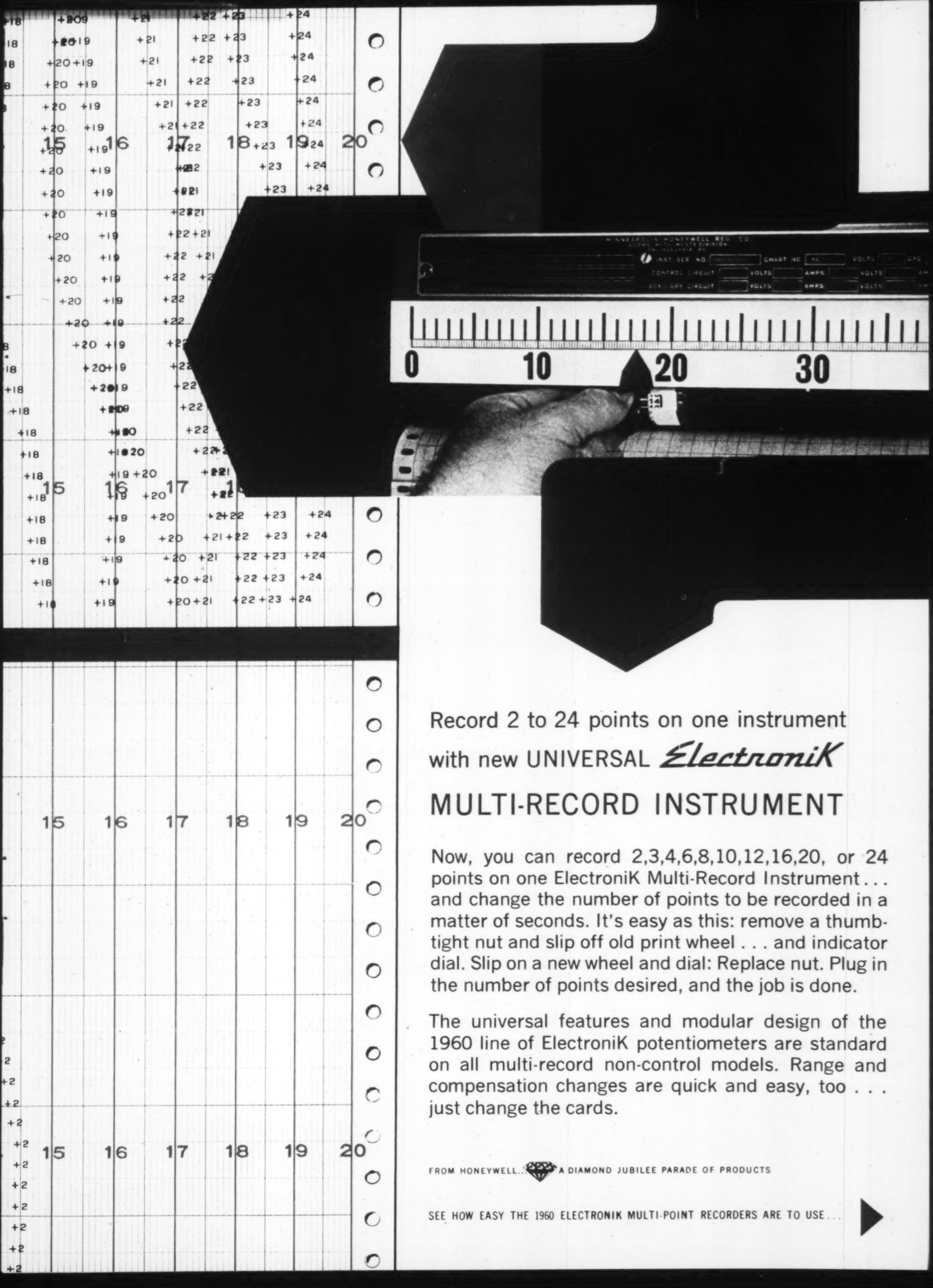


Record 2 to 24 points on one instrument with new UNIVERSAL *ElectroniK*

MULTI-RECORD INSTRUMENT

Now, you can record 2,3,4,6,8,10,12,16,20, or 24 points on one ElectroniK Multi-Record Instrument . . . and change the number of points to be recorded in a matter of seconds. It's easy as this: remove a thumb-tight nut and slip off old print wheel . . . and indicator dial. Slip on a new wheel and dial: Replace nut. Plug in the number of points desired, and the job is done.

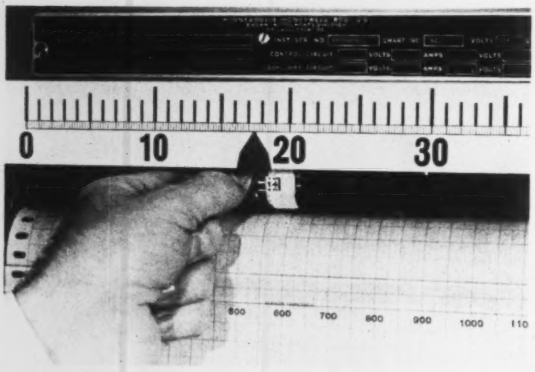
The universal features and modular design of the 1960 line of ElectroniK potentiometers are standard on all multi-record non-control models. Range and compensation changes are quick and easy, too . . . just change the cards.

FROM HONEYWELL... A DIAMOND JUBILEE PARADE OF PRODUCTS

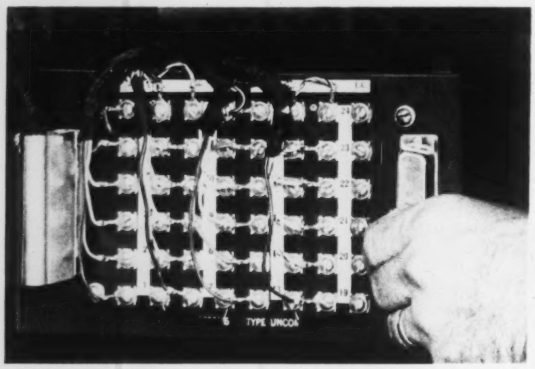
SEE HOW EASY THE 1960 ELECTRONIK MULTI-POINT RECORDERS ARE TO USE . . . ▶

all it takes with the 1960 *ElectroniK* MULTI-RECORD RECORDERS to change . . .

. . . number of points recorded



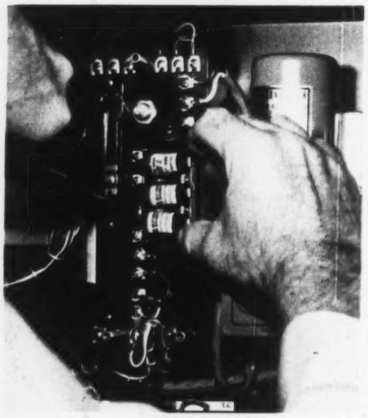
First: remove thumb-tight nut; slip off print wheel and indicator dial. Slip on new wheel and dial and replace nut.

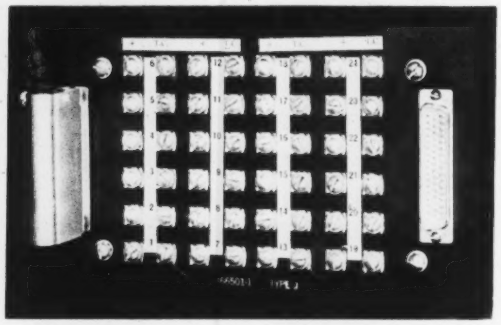


Second: replace one plug-in unit and the instrument is ready to record a different number of points.

The new flexibility and convenience of the 1960 ElectroniK Multi-Record Recorders should interest you. This new design has resulted in substantial manufacturing cost reductions which are reflected in our new price structure. Your nearby Honeywell field engineer has the full details. He's as near as your telephone. Minneapolis-Honeywell, Wayne and Windrim Avenues, Philadelphia 44, Pa.

. . . RANGE—Loosen screws and slide out the range resistor card. Replace with a different card, tighten screws and the job is done quickly and easily.





. . . COMPENSATION—The input terminal board with built-in reference junction comes out by removing one plug. Slide in the new board, replace the screws and plug and the compensation is changed.

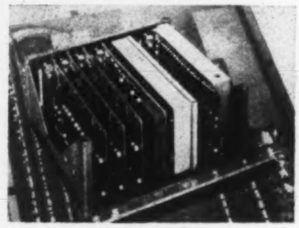
Honeywell

H HONEYWELL *First in Control*
SINCE 1885

75th YEAR PIONEERING THE FUTURE

AN/DIG CONVERTER

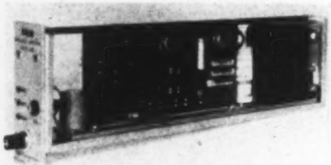
New airborne Analog-to-Digital Converter, Model M4, is said to be one- half the size and weight of previous converters. Completely transistorized, it performs a 12-bit conversion to an accuracy of ± 1 mv in 65 μsec. Available for 3-decimal digit as well as 12-bit binary conversion, it meets the conditions required of MIL-E-5400B and MIL-E-005272. Packaging of the M4 conforms to MIL-T-19600 (AER).—*Packard Bell Computer Corp.*, 1905 *Armacost Ave., Los Angeles* 25, *Calif.*



CIRCLE 224 ON READER-SERVICE CARD

FREQUENCY CONVERTER

New general-purpose Frequency-to-DC Converter for flow measurement, tachometry, etc. affords quick selection of various full-scale frequencies ranging from 500 cps to 100 kc by changing a single plug-in circuit board. Linearity is better than 0.1%. Drift with temperature change is less than ±0.1% from −15°C to +55°C. —*Vidar Corp.*, 2107 *El Camino Real, Palo Alto, Calif.*



CIRCLE 225 ON READER-SERVICE CARD

SHOCK RECORDER

New Shock Recording Accelerometer, Model A 12, responds to short duration shocks and indicates on a permanent record the greatest shock received. It utilizes a deformable plastic filament that is squeezed between an internal seismic mass and a glass window to indicate the magnitude of the shock. The width of the deformed filament may be visually read, and it is translatable into maximum G's of shock. Standard range is ±10 to 50 G's linear; 5 to 125 G's useable, with accuracy ±5 G's.—*Pace Engineering Co.*, 13035 *Saticoy St., North Hollywood, Calif.*

CIRCLE 226 ON READER-SERVICE CARD

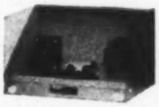
← CIRCLE 345 ON READER-SERVICE CARD

SPECIFIED
FOR MAKING SEMI-CONDUCTORS

Part of diffusion furnace room, Hoffman Electronics Corporation, El Monte, California. Process is one step in critical manufacture of silicon solar cells.

Gardsman by WEST

Model JSBG Stepless Program Controllers



Semi-conductors are grown by a highly integrated process, involving time-temperature control. Only the most precise control delivers the required quality, uniformity, efficiency.

Leading producers of semi-conductors find best results from the market's most compact, integrated Stepless Program Controller: by West. This unit infinitely modulates heater power *and* coordinates time-and-temperature control for even the most unstable systems.

Also available: models combining Gardsman off-on, proportioning or 3-position controllers with programming. All are *tubeless* and noted for minimum maintenance and operating requirements. Ask your West representative or write for Bulletin JSB and JG.

See us at the
29th National Packaging Exposition
Atlantic City, N. J.
Convention Hall
April 4-7, 1960—Booth 1220

WEST Instrument CORPORATION
SALES OFFICES IN PRINCIPAL CITIES
4355 W. MONTROSE, CHICAGO 41, ILL.

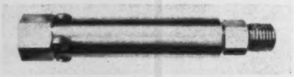
the trend is to WEST

British Subsidiary:
WEST INSTRUMENT LTD.,
52 Regent St., Brighton 1, Sussex
Represented in Canada by Davis Automatic Controls, Ltd

CIRCLE 96 ON READER-SERVICE CARD

MANOMETER CHECK VALVE

New Manometer Check Valve, Model 1636, for protection against loss of indicating fluid when over-range pressures are encountered, has a unique patented "O"-ring diaphragm which seals against the valve cone.—*Petrometer Corp., 43-22 Tenth St., Long Island City, N. Y.*



CIRCLE 227 ON READER-SERVICE CARD

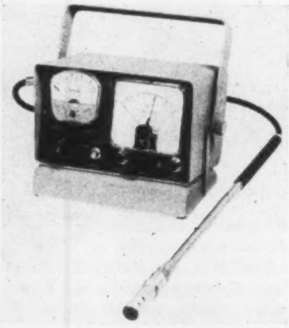
MINI INSTRUMENT PIVOTS

New line of miniature components includes Pivots, Shafts, and Pins. Pivots are machined from high-grade carbon steel, heat treated, and polished. Conical bearing point angles, from 45° to70° are accurately turned for perfect centering and smooth operating performaance. Available in 0.016" to 0.125" dia, and in lengths from 0.050" to 0.750" with radii from 0.0008" to 0.004".—*John Gillen Co., 2540 South 50th Ave., Cicero 50, Ill.*

CIRCLE 228 ON READER-SERVICE CARD

PROBE-TYPE GAS DETECTOR

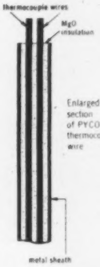
New Model 521 Gas Detector can be operated as portable instrument with handy probe-type element, or as fixed indicator/alarm with up to 100 ft of cable to detector element. Built-in solid-electrolite nickel-cadmium battery and battery charger provide for portable power. Calibrated in percent of lower explosion limit of desired gas.—*Houston Instrument Corp., Box 22234, Houston 27, Tex.*



CIRCLE 229 ON READER-SERVICE CARD

METAL-SHEATHED T/C WIRE

New self-powered Temperature packed, metal-sheathed thermocouple wire, is available in seven sizes ranging from ⅛" to 1/40" (0.025") sheath OD. Supplied in all standard ISA calibrations (T, J, K, E, R, and S) with Type 304 s.s., Inconel, and platinum as standard sheath materials.—*Pyrometer Co. of America, Inc., Penndel, Penna.*

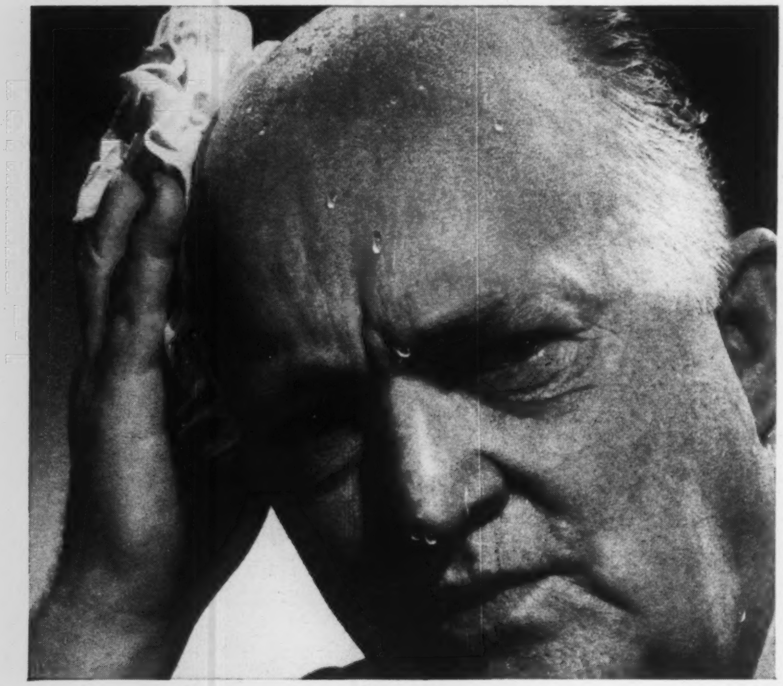


CIRCLE 230 ON READER-SERVICE CARD

REED CUT-OFF SYSTEM

New Magnetic Reed Cut-Off System, providing accurate cut-off control of scale loading, consists of a magnet, reed switch, and relay. Operating as a single-unit system, the pointer holding the reed switch is set to the point at which cut-off is desired. As the lead increases, the dial indicator travels up the scale until the magnet is opposite the switch and the reed makes contact and energizes the relay. A two-reed switch system can be used to provide control for two ingredients.—*Howe Scale Co., Rutland, Vt.*

CIRCLE 231 ON READER-SERVICE CARD



DON'T GET IN A **SWEAT** ABOUT **TEMPERATURE** CONTROL... **standardize on Bristol pyrometer supplies and solve the problem, once and for all.**

Everyone knows how interrupted pyrometer service can cut production, increase costs, impair product quality and whittle away at profits. Good way to minimize or stop these troubles: Lay in a supply of Bristol's thermocouples, protection tubes, radiation-unit accessories, refractory insulators, mounting fixtures, thermocouple extension wire, switches, and ink. They're available in sizes and types to fit all standard installations.

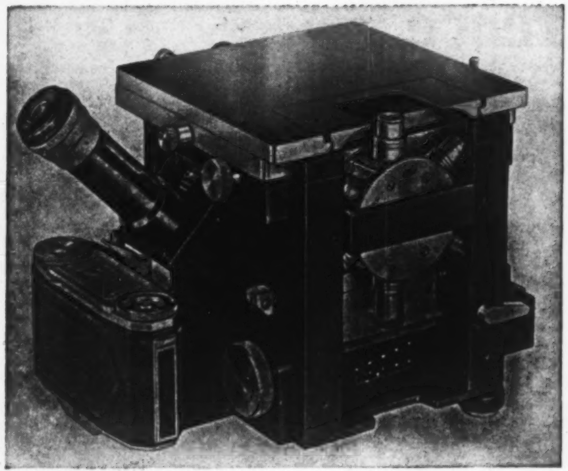
The outstanding quality and superlative reliability of Bristol pyrometer accessories is the product of more than 70 years of instrument building, 55 years of industrial pyrometry.

Write for complete data on Bristol pyrometer accessories today. The Bristol Company, 154 Bristol Road, Waterbury 20, Conn. O.12

BRISTOL ...for improved production through measurement and control

AUTOMATIC CONTROLLING, RECORDING AND TELEMETERING INSTRUMENTS

CIRCLE 97 ON READER-SERVICE CARD



Write for detailed literature and specifications on this industrial microscope.

CARL
ZEISS

WEST GERMANY

INTERFERENCE MICROSCOPE

For accurately measuring minute depths of roughness of super-finished surfaces, thickness of coatings, changes of surface structures due to wear, impact, stress, strain, corrosion, as well as for the studying of polished and etched metallurgical specimens.

Magnifications of 80x, 200x and 480x. Built-in Thallium and white light illuminators. Photography on 35mm film (1 x 1½ in.)

CARL ZEISS, INC.

COMPLETE SERVICE FACILITIES

485 FIFTH AVENUE, NEW YORK 17, N. Y.

CIRCLE 98 ON READER-SERVICE CARD

EPLAB

Thermopiles

For many years the thermopile has been the accepted instrument for measuring Radiant Heat from Radiant Heaters at the American Gas Association Testing Laboratory in Cleveland, Ohio. Since 1930, when Vandaveer first described his work in this field,* an Eppley thermopile has been used for this purpose in hundreds of tests and the results have been consistent and accurate to within 1 per cent.

This is but one of many applications in the field of radiant energy measurements for which Eppley Thermopiles are ideally suited. They may be obtained with windows of different materials, and various types of black are available for receiver coatings.

All Eppley Thermopiles are supplied with a certificate of calibration, this calibration being made against a Standard Lamp from the National Bureau of Standards.

If you have a problem involving the measurement of radiant energy we invite you to write us, describing your problem in as much detail as possible. We will be glad to make recommendations and there will be no obligation.

**Vandaveer, Industrial & Engineering Chemistry, Vol. 22, page 596, June 1930.*

***BULLETIN No. 3 ON REQUEST*—Address: 2 Sheffield Ave., Newport, R. I.**

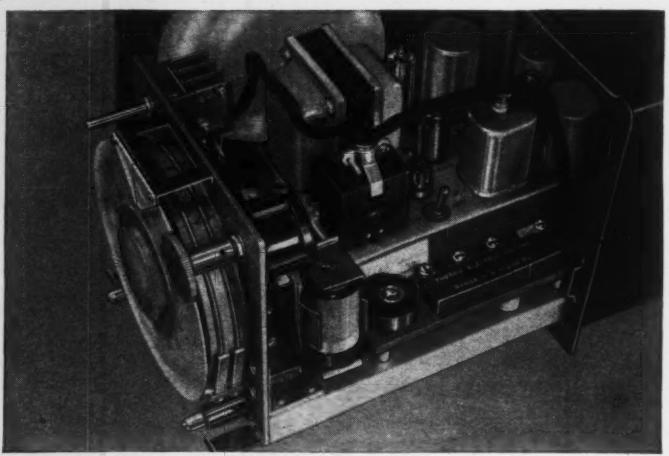
THE EPPLEY LABORATORY, INC.

SCIENTIFIC INSTRUMENTS

NEWPORT, RHODE ISLAND, U. S. A.

CIRCLE 99 ON READER-SERVICE CARD

Size makes the difference



in the

Ultimate in convenience—all components accessible on slide-out chassis.

Thermo Electronic® Signaling Controller

This new, rugged, compact off-on signaling controller is simply designed, using proven components, to give you maximum accuracy, sensitivity and speed of response, in a minimum of space.

Available as a potentiometer or bridge type unit. It will automatically, continuously, dependably provide two position control of any process you require, through the use of any DC signaling transducer. Corrective action follows almost instantaneously upon detection of even a 1 microvolt signal change.

Bright Red-Green lights on the panel door signal process condition. The instrument needs just 56 square inches of your panel space.

The Thermo Electronic Signaling Controller incorporates the new high-gain relay amplifier which combines high stability with exceptional sensitivity. Stability is ± 1 microvolt, power gain, 135 decibels. Full amplifier sensitivity is used for standardizing.

Tubes and parts are standard—obtained easily from any electronic parts outlet. The potentiometer circuit uses a flashlight battery as its power source. Front-set controls enable quick setting. Easily interchanged ranges, from 1-100 millivolts, adapt to an exceptionally wide range of sensing elements. Fail-safe action protects expensive process equipment against transducer, component or power failure.

Thermo Electronic

15.8″ scale has large, easy-to-read numerals.

Solve your two-position control problems quickly and better with Thermo Electronic Instruments.

Write today for Catalog 51-12

Thermo Electric CO., INC. **SADDLE BROOK, NEW JERSEY**

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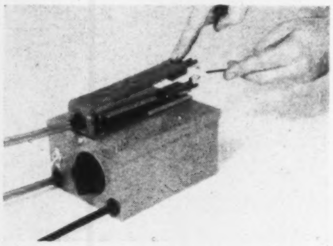
CIRCLE 100 ON READER-SERVICE CARD

WIRE STRIPPER

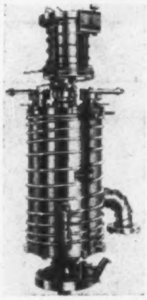
New Model G Thermal Wire Stripper which features a continuously-variable heat control for precise temperature adjustment required in stripping plastic-insulated wire, uses two parallel heating elements to quickly sever plastic insulation, and provides a pincers action to remove it with a slight pull. Strips Teflon as well as lower-melting materials such as vinyl, nylon, Mylar, Dacron, rayon, polyethylene, etc.—*Western Electronic Products Co.*, 655 *Colman St., Altadena, Calif.*



CIRCLE 232 ON READER-SERVICE CARD

VACUUM FURNACE

New High-vacuum Furnace, Model 58-HD, for hardness tests up to 3000° F has a cylinder of sheet molybdenum, 3″ ID x 12¾″ lg., as heating element. It can be readily evacuated at room temperature to a pressure of 1×10^{-5} mm Hg by a 2″ diffusion pump backed by a 4 cu-ft rotary gas ballast double-stage pump. Normal pressure at 3000°F with this pumping system is in the range of 1×10^{-4} mm Hg.—*Marshall Products Co.,* 270 *W. Lane Ave., Columbus* 2, *Ohio.*

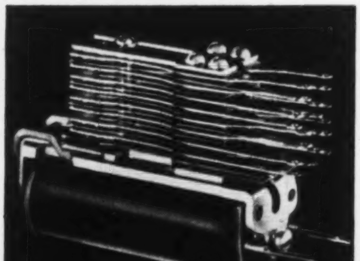


CIRCLE 233 ON READER-SERVICE CARD

PROVING RINGS

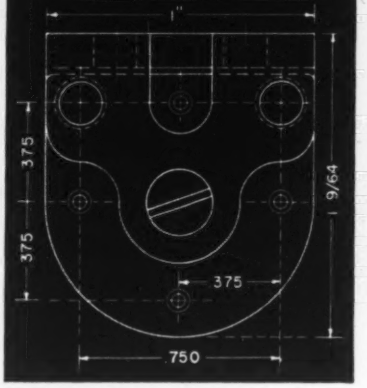
New vernier scale as optional attachment has been added to Proving Rings. The measuring device indicating ring deflection, consists basically of a vibrating reed and a micrometer screw which measures within 0.00001″. The addition of the vernier scale facilitates reading with maximum accuracy.—*Morehouse Machine Co.,* 1742 *Sixth Ave., York, Pa.*

CIRCLE 234 ON READER-SERVICE CARD



Telephone Relay

interchangeable with many other makes



Stromberg-Carlson's type "E" relay combines the time-proven characteristics of the type "A" relay with a mounting arrangement common to many other makes.

As the drawing above shows, universal frame mounting holes and coil terminal spacing allow you to specify these relays—*of "telephone quality"*—interchangeable with the brands you have been using. Costs are competitive and expanded production means *prompt delivery.*

Welcome engineering features of the telephone type "E" relay are—

Contact spring assembly: maximum of 20 Form A, 18 B, 10 C per relay.

Coil: single or double wound, with taper tab or solder type terminals at back of relay.

Operating voltage: 200 volts DC maximum.

You may order individual can covers in a choice of 3 sizes for the new relay, as well as for our type "A" and "C" relays.

For complete details and specifications on the "E" relay and other Stromberg-Carlson relays, send for your free copy of Catalog T-5000R2. Write to Telecommunication Industrial Sales, 113 Carlson Road, Rochester 3, New York.

STROMBERG-CARLSON
A DIVISION OF
GENERAL DYNAMICS

CIRCLE 101 ON READER-SERVICE CARD

DC POWER SUPPLY

New fully-transistorized, fully-enclosed D-c Power Supply, having a rating of 4 to 35 v at 0 to 4 amp, mounts in a 19" rack, 3½" high, 10" deep. Output voltage is continuously variable. Regulation is 0.1% for load and line variations with no internal adjustments.—*Dynamic Controls Co., 1955 Massachusetts Ave., Cambridge 40, Mass.*

CIRCLE 235 ON READER-SERVICE CARD

AMPLIFIER PACKAGE

New Dual-Channel Portable Amplifier System provides a convenient power source for driving Massa pen motors or other recording galvanometers. Basic Unit, Model ASA-200, consists of two completely transistorized driver amplifiers in a portable cabinet. Any two Massa interchangeable preamplifiers may be plugged into the basic unit.—*Massa Div of Electronics, Inc., 5 Fottler Rd., Hingham, Mass.*

CIRCLE 236 ON READER-SERVICE CARD

OIL-FREE COMPRESSOR

New line of portable, oil-free, piston-type Air Compressors features a non-lubricated piston (which includes a specially compounded Teflon cup backed up by a silicone "O"-ring) and a s.-s. cylinder liner. Receiver tanks, pressure switches, regulators, gages, relief valves, moisture traps, and air purifiers are available as accessories.—*Winslow Mfg. Corp., 3695 East 10th Court, Hialeah, Fla.*

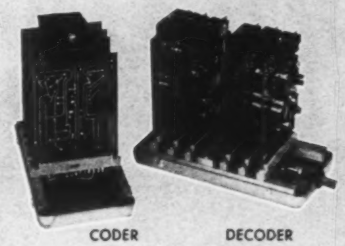
CIRCLE 237 ON READER-SERVICE CARD

billions of trouble-free operations with

MONITRON

all-solid-state SEQUENTIAL SCANNERS

MONITRON is an electronic scanner which monitors from 8 to 256 on-off or go-no-go input signals. Scanning rates range from 15 cps to 1 kc, meeting the bandwidth requirements of almost any application.



- **All solid-state components** for years of reliable, maintenance-free service
- **Modular, plug-in design** for instant replacement and future system expansion
- **Fully compatible** with existing telephone, telegraph and microwave practice
- **Available either in integrated systems or component modules**

Anywhere you have need for alarm monitoring, centralized control, or an automatic alarm-and-control closed loop, you'll find that Monitron offers performance advantages over any other system.

Monitron is widely used for supervisory control in pipeline and railroad applications, for microwave alarm systems in unattended stations, and for PDM multiplexing systems. Other uses include telemetering digital information, converting parallel data to serial data, and time multiplexing of slowly changing or quasistatic signals. Cost is comparable with older-style systems; reliability and ease of operation are way ahead.

For more information:

RESEARCH & DEVELOPMENT • PRODUCTION

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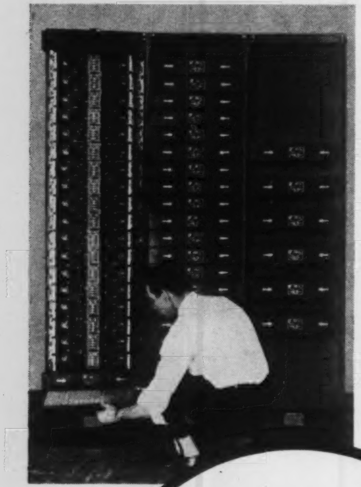
2600 SPRING ST. REDWOOD CITY CALIFORNIA

CIRCLE 102 ON READER-SERVICE CARD

REMOTE INSTRUMENTATION & CONTROL



UP TO

37 CHANNELS

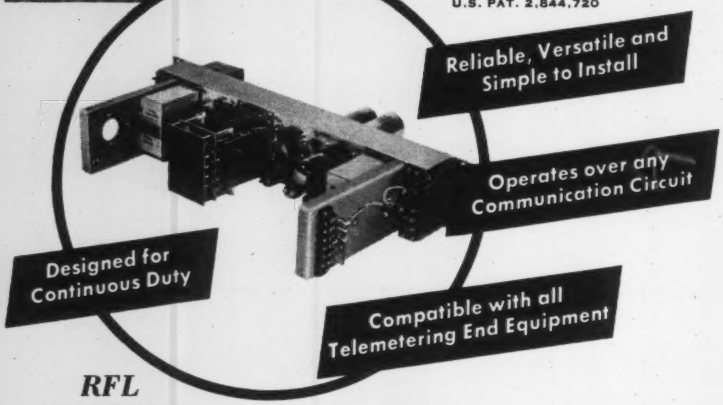
in the Voice Band!

with

Comvor®

DATA TRANSMISSION TERMINAL

U.S. PAT. 2,844,720


Reliable, Versatile and Simple to Install
Operates over any Communication Circuit
Designed for Continuous Duty
Compatible with all Telemetering End Equipment

RFL
Model 912
Operates over
Wire Circuit
or Microwave
•
Reliable
High Speed
Continuous
Control of
Pumps, Valves,
Motors, Relays,
Generators, etc.

The Model 912 Comvor, an audio frequency shift terminal, is used in the transmission of telemeter, telegraph or control signals over either wire line, microwave, or carrier. Up to 90 individual information channels are available in the audio spectrum.

Reliable frequency shift method of keying is used. All essential controls such as transmitter output level and receiver input level are included.

Each terminal contains its own power supply which provides an additional 60 milliamperes at both the transmitter and receiver for the operation of relays, stepping switches, selector magnets, and other components used in telemetering, control and telegraph applications.

RFL REPRESENTATIVES:

ILL., MINN., IOWA, IND., WISC.
W. L. Cunningham, Elmhurst, Ill.
TEXAS, ARK., LA., OKLA.
Datatrol Co., Dallas, Texas
ALA., TENN., VA., N.C., S.C., GA.
Dickerson Eng., Jacksonville, Fla.
CALIFORNIA
Luscombe Engr., Pasadena, Calif.
ORE., WASH.
J. E. Edstrom, Portland, Ore.
CANADA
Microwave Sys., Scarborough, Ont.
FOREIGN
Telesco International, New York

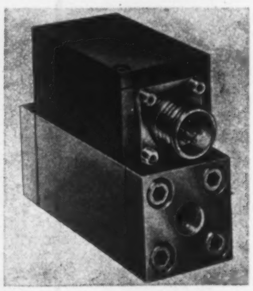
SEND FOR TECH. DATA — For additional information, including application data, write or phone DE 4-3100. Demonstrations available by local representatives.

RFL
Radio Frequency
LABORATORIES, INC.
Boonton, New Jersey, U. S. A.

CIRCLE 103 ON READER-SRVICE CARD

DIFF PRESS TRANSDUCER

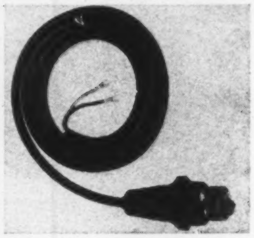
New high-frequency-response Differential Pressure Transducer, Model PT69, is available in both uni-directional pressure ranges from 0-to-10 psid to 0-to-3000 psid, and bi-directional pressure ranges from ±5 to ±1500 psid. Suited for corrosive and conductive media.—*Dynisco, Inc.*, 42 *Carleton St., Cambridge* 42, *Mass.*



CIRCLE 238 ON READER-SERVICE CARD

CONDUCTIVITY CELL

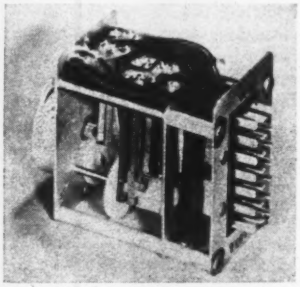
New electrolytic conductivity cells with extra low cell constants of 0.001/cm and 0.002/cm provide full scale ranges of 0-1 or 0-0.5 micromhos/cm specific conductance for ultra pure demineralized water applications, etc.—*Industrial Instruments Inc.*, 89 *Commerce Rd., Cedar Grove, N. J.*



CIRCLE 239 ON READER-SERVICE CARD

REPEAT CYCLE TIMERS

New line of low-cost, long-life Repeat Cycle Timers of 4" x 3" x 2" size features spring switches in plastic contact blocks, molded nylon cams, cam followers and gear assemblies, printed circuit cables, and Jones-type terminal plugs.—*A. W. Haydon Co.*, 232 *North Elm St., Waterbury, Conn.*



CIRCLE 240 ON READER-SERVICE CARD

THE FLOW
GOES
STRAIGHT-THRU

THIS ALL-NEW
BROOKS
MAGPNUTRAX
TRANSMITTER

no pockets, no elbows
to gum up the works!

This is the rotameter-transmitter for your toughest flow-metering jobs. Brooks' new Model 3611-MPTX.

You can use it for slurries, still bottoms, Bunker oils, pthalic anhydrides, tall-oil compounds—virtually any 'problem' fluid.

You can use it for electric transmission, pneumatic transmission, or flow integration—or transmission *and* integration.

Above all, you can use it with absolute confidence.

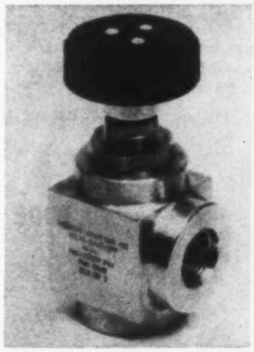
Have a look at the transmitter's unique magnetic float-position converter, and you'll see why.

Design Specification Sheet DS-361 gives details. Write for a copy.

BROOKS
ROTAMETER COMPANY
360 J STREET
LANSDALE • PENNSYLVANIA

CIRCLE 104 ON READER-SERVICE CARD

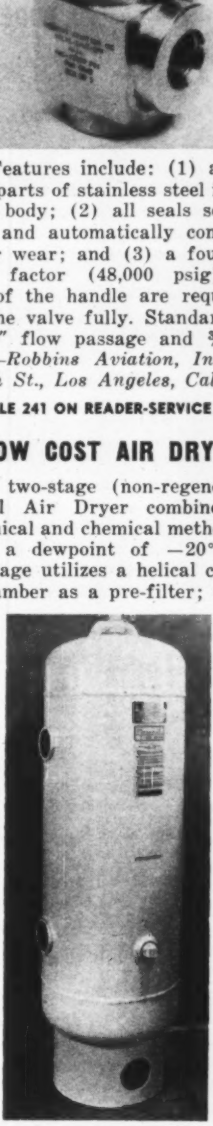
PRESSURE BALANCED VALVES



New Series 400 Pressure-balanced Valves, suitable for acids, gases, fuels, corrosive chemicals, oxygen, etc., require only 30 in-lb torque to shut off bubble-tight against 12,000 psig. Features include: (1) all functional parts of stainless steel in a s.-s. forged body; (2) all seals self-energizing and automatically compensating for wear; and (3) a four-to-one safety factor (48,000 psig). Five turns of the handle are required to open the valve fully. Standard valve has ½" flow passage and ¾" tube ports.—*Robbins Aviation, Inc.*, 2350 *E. 38th St., Los Angeles, Calif.*

CIRCLE 241 ON READER-SERVICE CARD

LOW COST AIR DRYER



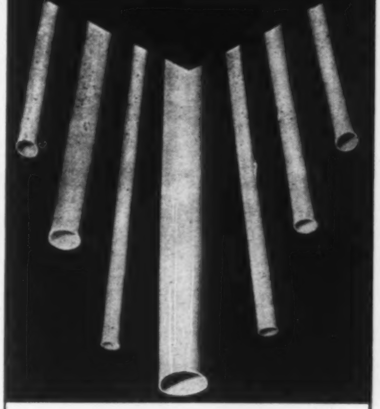
New two-stage (non-regenerative) General Air Dryer combines both mechanical and chemical methods providing a dewpoint of −20°F. The first stage utilizes a helical centrifugal chamber as a pre-filter; the second stage uses a desiccant, "General Beads," a polychemical base, which requires no heat treatment. 12 standard models are available ranging up to 2250 scfm.—*General Welding & Fabricating Co.*, 1702 *Peninsula Drive, Erie, Pa.*

CIRCLE 242 ON READER-SERVICE CARD

for missile and radar sleevings,
cable sleevings, barrier insulation,
and similar applications,
use large size

PF

Electrical Tubing
MADE FROM
TEFLON*



PF tubing made from Teflon in sizes from ⅜" to 1" for electrical applications is widely used because of:

1. the OUTSTANDING electrical and physical properties of Teflon, including: dielectric breakdown (18,000 volts or greater); lowest dielectric constant (2.0); no change of electrical properties with temperature (−25°C. to +250°C.) or frequency (60 cycles to 100 mc); unaffected by moisture; low coefficient of friction; flexibility; very low permeability.

2. the OUTSTANDING design, engineering and production techniques developed by Pennsylvania Fluorocarbon to assure you of: tubing that is consistently uniform in dimensions; prompt deliveries; the tailoring of Teflon with colors for identification or with modifications for improved texture and mechanical properties; competitive prices.

Write, wire or call for a prompt quotation on your needs.

PENNSYLVANIA
FLUOROCARBON CO., INC.
1115 N. 38th Street, Phila. 4, Pa.
EVergreen 6-0603 TWX: PH 252

*Du Pont registered trademark

CIRCLE 105 ON READER-SERVICE CARD

an economical
new line of
**DIGITAL
TEST
EQUIPMENT**

New low-speed, low-cost version of Digital's unique patchcord-interconnecting building block test units.

NEW
3000
SERIES

**Coordinated logic packages
Operate at any speed up to 500 kc.
Directly compatible with 5 mc. line
Priced as low as $43.00 per unit**

Graphic front panels — a Digital first — make the 3000 Series ideal for educational uses. Also a great time- and work-saver in test and development projects. Write for complete information on this new line of high quality, high reliability DEC Digital Test Equipment.

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EQUIPMENT
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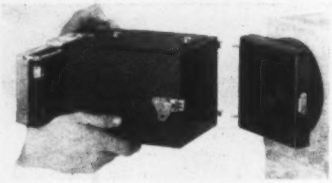
CIRCLE 106 ON READER-SERVICE CARD

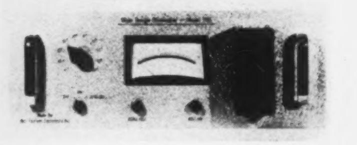
OSCILLOSCOPE CAMERA



New modular Oscilloscope Recording Camera "Minute Man Oscillotron," said to be simplified, features a Polaroid-Land back providing either 60-sec prints or transparencies. Attaches to any 5" oscilloscope. Wollensak 75mm, f/2.8, f/1.9 standard, or f/1.9 flatfield lenses are interchangeable.—*Beattie-Coleman, Inc., 1056 N. Olive St., Anaheim, Calif.*

CIRCLE 243 ON READER-SERVICE CARD

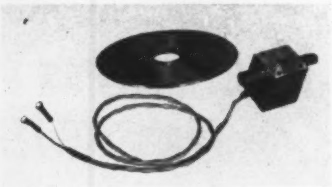
WIDE RANGE OHMMETER



New Wide Range Ohmeter uses an extremely low test potential which makes it especially suited for measurement of semiconductors. Power dissipated in sample is 0.036mw, and at 500 K only 0.0004 μw. Range is 50 mohms to 5,000 Mohms. Accuracy is approx. ±3.0% of scale length.—*Mideastern Electronics, Inc., 32 Commerce St., Springfield, N. J.*

CIRCLE 244 ON READER-SERVICE CARD

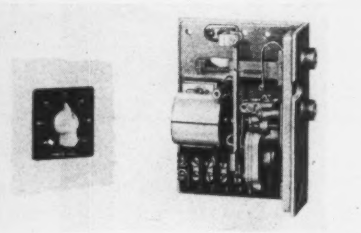
MINIATURE RADIOMETER



New water-cooled Miniature Radiometer for measurement of short pulses of every intense thermal radiation such as in solar or arc furnaces requires only effective area of 0.001 sq in and has high response speed of less than 0.01 sec.—*Arthur C. Ruge Associates, Inc., Hudson, N. H.*

CIRCLE 245 ON READER-SERVICE CARD

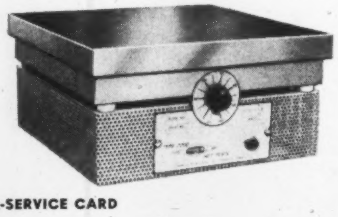
LOAD LIMITING RELAY



New R-27 Load Limiting Relay for pneumatic control systems on centrifugal refrigeration compressors limits the opening of the capacity regulating inlet valves or dampers to maintain a predetermined maximum motor current regardless of the demands of other controllers.—*Johnson Service Co., 507 East Michigan St., Milwaukee 1, Wis.*

CIRCLE 246 ON READER-SERVICE CARD

HOT PLATES



New series of Hot Plates, Type 2200 Thermolyne, features a bimetallic control unit for stepless control of temperature from 10° above ambient to 700°F. Operation is from 115-v or 230-v line. Bulletin HP-221 gives details.—*Thermo Electric Mfg. Co., 536 Huff St., Dubuque, Iowa.*

CIRCLE 247 ON READER-SERVICE CARD

MICROHM-READING BRIDGE

New Kelvin Bridge, Model 633, with range from 10 microhms to 100 ohms can use test leads up to 100 ft and above while maintaining an accuracy of ± 0.25% above 100 microhms and ±1 microhm below 100 microhms.—*Shallcross Mfg. Co., Selma, N. C.*

CIRCLE 248 ON READER-SERVICE CARD

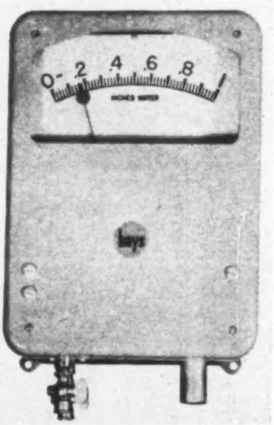
MINI DELAY LINE

New Type 7C Series Miniature Delay Line; which meets the need of compact delay lines with low attenuation, linear phase shift characteristics and wide bandwidth for applications such as computers, radar and power circuits; features hermetically-sealed construction, operating temperature ranging from −35°C to +125°C with 500-v peak working voltage, and temperature coefficient 0.005%°C. Rise time is 7% of the time delay for most types. Frequency response is over 10 mc bandwidth with attenuation less than 1.2 db/μsec delay at low frequencies.—*AD-YU Electronics Lab., Inc., 249-259 Terhune Ave., Passaic, N. J.*

CIRCLE 249 ON READER-SERVICE CARD

PRESSURE INDICATOR/ TRANSMITTER

New Model 231 Indicating Transmitter, for pressure indication at point of measurement or within 300 ft, electrically transmits the measurement to any Hays remote-located recorder or indicator. Applications include measurement of pressure (or draft), differential pressure (flow) of air or non-corrosive gases (ranges from 0-0.2" to 0-120" WC), and static pressure up to 65 psig.—*Hays Corp., Michigan City, Ind.*



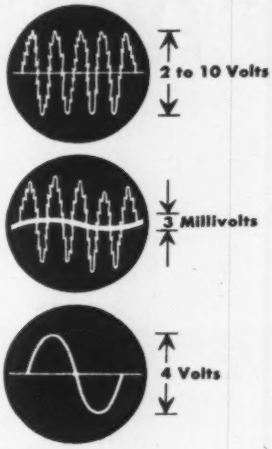
CIRCLE 250 ON READER-SERVICE CARD

from Honeywell... ANOTHER DIAMOND JUBILEE PRODUCT

WHEN YOU HAVE
extraneous common mode signals

AND WANT TO MEASURE
0.1 to 100 millivolts full scale

AND THEN AMPLIFY



CHOOSE THE NEW HONEYWELL D-C AMPLIFIER

AccuData II

wide-band differential all-transistor D-C Amplifier for strain gages and thermocouples

- **Full Scale Input:** Unbalanced: ±100 μv to ±100 mv
  Differential: ±3 mv to ±100 mv
  Open Loop: Below drift level
- **Full Scale Output:** ±2v at 50 ma, dc to 10 kc
- **Frequency Response:** to 20 kc
- **Output Impedance:** Less than 0.5 ohm at dc on all ranges
- **Input Impedance:** Unbalanced 3 to 100 mv ranges; greater than 20 megohms in parallel with 350 micromicrofarads. Differential: Greater than ± 2 megohms
- **Equivalent D-C Input Drift:** Less than 2 μv/10°F ambient temp change on 0.1 to 30 mv input ranges
- **Equivalent Input Noise:** 4μv peak-to-peak on 100 μv to 300 μv range (0-10 cps). 8μv rms on 10 to 30 mv ranges (0 to 100 kc)
- **Common Mode Rejection:** 200,000 at 60 cps on 3 to 30mv ranges

The new Honeywell AccuData II is a completely transistorized D-C Amplifier designed for use in high accuracy data handling systems as a wide-band pre-amplifier for strain gages and thermocouples. Its output can be fed to electronic or electromechanical analog-to-digital converters and simultaneously recorded on galvanometer oscillographs or magnetic tape. Either differential or single-ended input modes can be selected by an eleven position range switch. This switch changes the gain in three-to-one steps. Intermediate gains with high resolution are provided by a ten-turn potentiometer Write for AccuData II Bulletin to Minneapolis-Honeywell, Dept. 50, Boston Division, 40 Life Street, Boston 35, Mass.

Honeywell
H HONEYWELL *First in Control*
SINCE 1885

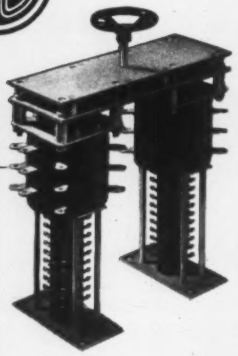
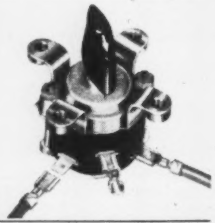
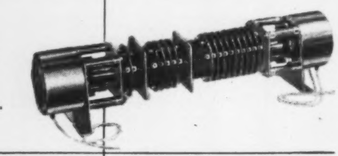
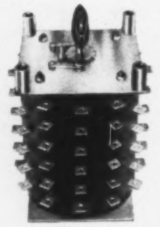
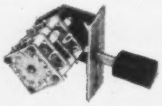
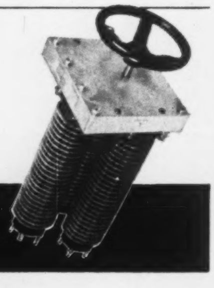
CIRCLE 107 ON READER-SERVICE CARD

ROTARY multi-pole multi-circuit SWITCHES

— standard or special —
to meet your requirements and
MIL or BuShips specifications
for simple or complex circuit control.

Here are typical designs that show the versatility of Esco construction.

Write for Bulletin 8A or call us for details.

Style and Size	Loads and Circuits	
Single-control tandem pair; snap-action; 7 × 19 inches × 20 inches behind panel. 75 lbs. approx.	200 amps. 500 v. a-c 6-pole, triple-throw; 30 amps. 500 v. a-c 20-pole, triple-throw.	
Quick-connect terminaling for snap-on wiring; 3¼ inches diameter, 3 inches behind panel. 8 oz. approx.	10 amps. 125 v. a-c single-pole 4-position; snap action.	
2-way drive by 6-volt solenoids; 3⅞ inches diameter, 18½ inches long. 12 lbs. approx.	10 amps. 125 v. a-c 34 poles, 2 positions.	
High-current low-voltage tap switch; 10¾ × 10¾ inches, 14 inches behind panel. 25 lbs. approx.	150 amps. 6 v. a-c 6-pole 12-position.	
Lever-actuated miniature switch; 1¼ × 1¾ inches. 1¼ inches behind panel. 2 oz. approx.	3 amps. 125 v. a-c 4-pole 3-position.	
3-gang, gear-drive single-control switch; 6 9/16 × 7 1/16 inches × 14 inches behind panel. 25 lbs. approx.	5 amps. 125 v. d-c 75 poles 2 positions.	

ESCO of WEYMOUTH
ELECTRO SWITCH CORPORATION
167 King Avenue, Weymouth 88, Massachusetts

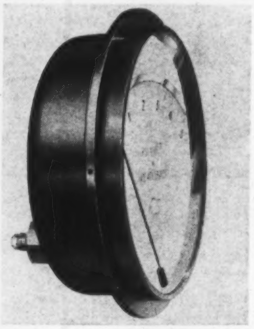
CIRCLE 108 ON READER-SERVICE CARD

MINI CIRCUITRY TERMINAL

New very small Push-in Terminal, T28, for 1/16" round holes, has serrations in the main slot gripping small component leads, which make it ideal for experimental breadboarding. No staking is needed.—*Vector Electronic Co., 1100 Flower St., Glendale 1, Calif.*

CIRCLE 251 ON READER-SERVICE CARD

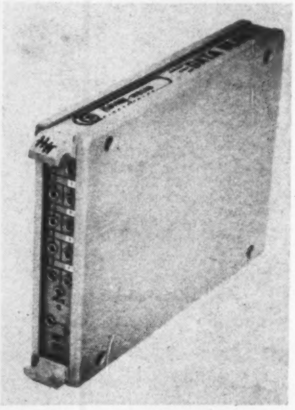
LAB PRESSURE GAGE



New gearless 6" Pressure Gage is said to retain its accuracy permanently, with no maintenance or recalibration required throughout its life, even when exposed to extreme shock, vibration, and line pressure surges. Individually calibrated by dead weight tester to a guaranteed accuracy of ±¼ of 1%, they are now available in pressure ranges from 0-100 to 0-10,000 psig. Measuring element is a helically wound bourdon tube.—*Glassco Instrument Co., 777 South Arroyo Parkway, Pasadena, Calif.*

CIRCLE 252 ON READER-SERVICE CARD

SHIFT REGISTER

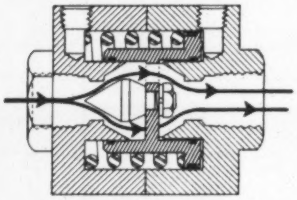


New low-cost, high-speed, four-stage Shift Register, Model 1801, featuring three inputs and eight outputs, can be cascaded to form a multistage shift register. This new digital component replaces four standard flip-flop B units.—*Harvey-Wells Electronics, Inc., R & D Div., East Natick Industrial Park, Natick, Mass.*

CIRCLE 253 ON READER-SERVICE CARD

IN-LINE VALVE

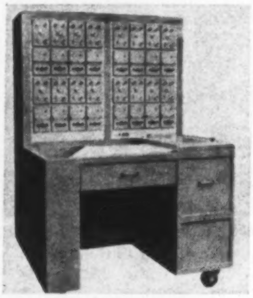
New compact ½" In-Line Valve has a C_v of 7.5 (normal ½" valves have C_v of 4.0). Only 2¾" in dia and 3½" in length including hexagonal, screwed connections, it is ported on both sides of the operating piston and can be assembled for spring-to-open or spring-to-close operation. Can be furnished with Teflon or other soft seats and can be engineered to specific requirements for control signal actuation. Viton "O" rings are available for corrosive and high-temperature applications.—*George W. Dahl, Co., Inc.*, 86 *Tupelo St., Bristol, R. I.*



CIRCLE 254 ON READER-SERVICE CARD

16-CHANNEL RECORDER

New Multi-Channel Recorder of modular construction has interchangeable pre-amplifiers and drivers which permit rapid change-over from one test to another. Five modular pre-amplifiers are stocked.—*Epsco/Worcester, a Div. of Epsco Inc.*, 207 *Main St., Worcester* 8, *Mass.*



CIRCLE 255 ON READER-SERVICE CARD

DIGITAL LOGIC BLOCKS

New line of compatible Transistorized Digital Logic Blocks for adding digital functions to new or existing systems and equipment, available with either of two standard types of mountings, computer and panel, features low power consumption and complete compatibility between blocks. —*Control Equipment Corp.*, 19 *Kearney Rd., Needham Heights* 94, *Mass.*

CIRCLE 256 ON READER-SERVICE CARD

Model
1342
Price
$555

HI ACCURACY 0.2%
LO CAPACITY .002 μμF

New Marconi Capacity Bridge enables difficult measurements such as temperature co-efficients, circuit strays and tube interelectrode capacities to be easily made. Capacitors already wired into circuits can be checked **without removal** by the three terminal "in situ" method.

Model 1342 uses the transformer ratio arm technique which permits measurement of small capacities at the end of long screened leads to be measured without loss of accuracy.

Brief Specification

Range: 0.002 to 1,111 μμF
Accuracy: ±0.2%
Resistance range: 1 to 1000 MΩ
Frequency: 1 Kc
Decimal point inserted automatically

I.R.E. SHOW

BOOTHS 3301-3-5

MARCONI INSTRUMENTS

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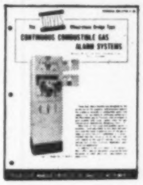
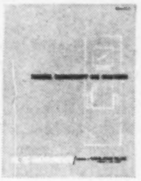
INSTRUMENT DAVIS DIVISION

Gas Analysis Instrumentation





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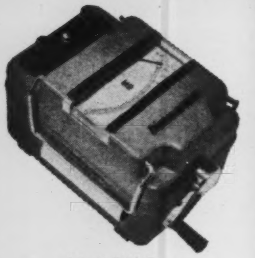
Model L-5

DC: Model MPF
AC: Models SPF CPF
HF: Model TPF

Insulation Tester
Model L-5

Vacuum Thermocouple
(Instrument type)
Models VL-25, VL-7

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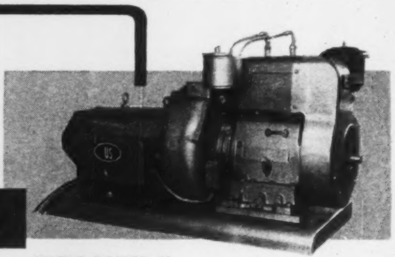
MICRO POWER



In plants like Douglas Aircraft Company, Inc., in Tulsa, Oklahoma, where a continual supply of steam is vital to production processes, every precaution must be taken to assure against the hazards of boiler flame-out. To safely regulate its burners in the event of flame-out, the company utilizes highly sensitive electric controls. Since these flame failure controls *are* electric and must depend on a constant, unwavering power supply for successful operation, this is achieved with MICRO POWER.

At Douglas Aircraft in Tulsa, Micro Power serves as the dependable rear guard to the boiler room. It provides a constant source of steady, independent electrical power as required by the safety controls, thereby eliminating voltage fluctuations and protecting against power failure.

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- on microwave systems for communications, for remote control, for telemetering.
- for refinery and chemical process indication and control.
- by public utilities through microwave for protective relaying, telemetering and load distribution.

MICRO POWER PROVIDES . . .

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- stable voltage output.
- flywheel starting — no storage batteries.
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For complete information on this and other Micro Power applications, write . . .

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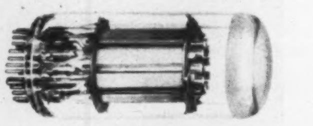
102 W. 5th Avenue • Oshkosh, Wisconsin

CIRCLE 112 ON READER-SERVICE CARD

DECIMAL ELECTRONIC SWITCH

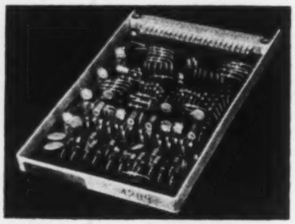
New Beam-X Switch combines vacuum and magnetic techniques in a functional decimal electronic switching device said to be a revolutionary breakthrough in size, weight, cost, and important operating parameters. It performs such digital functions as counting, distributing, multiplexing, sampling, coding, timing, gating, matrixing, dividing, decoding and converting. Ten outputs make it essentially ten devices in one. It eliminates 90 transistors, diodes and resistors in a typical ten-position switching application. Each of the device's ten positions has (a) memory, (b) constant current output, and (c) positive switching elements to ensure stability of operation.—*Burroughs Corp., Electronic Tube Div., Plainfield, N. J.*



CIRCLE 257 ON READER-SERVICE CARD

DUAL FLIP-FLOP

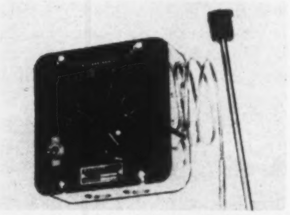
New Dual Flip-Flop package, Type 4209, the "4000 Series" of System Building Blocks, operating at speeds up to 500 kc has a direct and gated input to the zero and one side, and each has one pulse gate internally connected to the gated one input terminal.—*Digital Equipment Corp., Maynard, Mass.*



CIRCLE 258 ON READER-SERVICE CARD

TEMPERATURE CONTROLLER

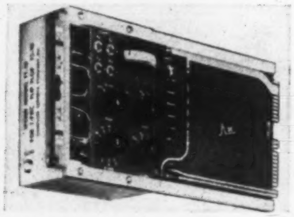
New non-indicating Temperature Controller for range of 0°F to 1100°F is suitable for direct operation of non-inductive electrically heated processes or operating electric switchgear for diversified electric loads. A liquid-filled bellows-type instrument it is bimetal compensated for ambient temperature changes. Case is a 4" square x 2" deep.—*R. A. Ekstrom Co., Box 206, Harvey, Ill.*



CIRCLE 259 ON READER-SERVICE CARD

STATIC FLIP-FLOP TESTER

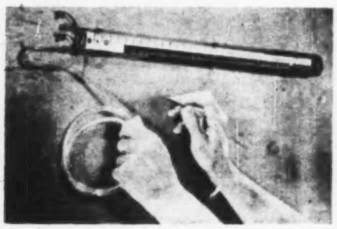
New package Tester, Model FT-10, which affords a complete test facility for its transistorized static flip-flop Model FS-10, consists of control switches, a microammeter, and oscilloscope test points.—*Computer Control Co., Inc.*, 983 *Concord St., Framingham, Mass.*



CIRCLE 260 ON READER-SERVICE CARD

DUAL MANOMETER

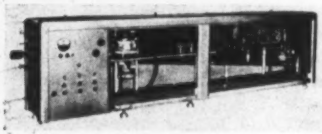
New low-cost Dual-Range Manometer, No. 1226 can be used either as a vertical U-tube- or as an inclined-manometer for low pressures. Said to be the only one of its kind with this unique feature, U-tube manometer measures pressures or pressure differentials from 0 to 16" W.C. Inclined gage reads from 0.20" to 0 to 2.60" WC. Offered in a complete package including tubing, carrying case, and all accessories. U-tube is extruded from heavy, transparent Butyrate and the flexible connecting tube is from clear Tygon.—*F. W. Dwyer Mfg. Co., Dept. IT-5, Box* 373, *Michigan City, Ind.*



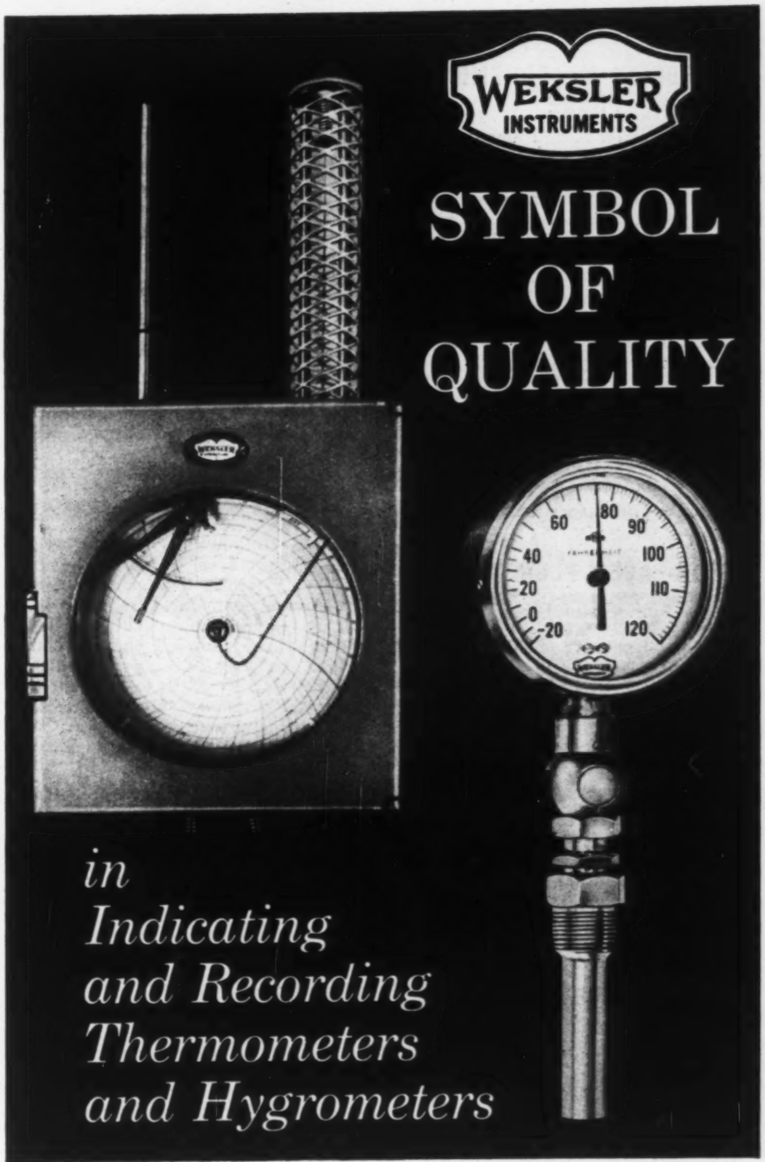
CIRCLE 261 ON READER-SERVICE CARD

BEAM BALANCE

New automatic indicating Beam Balance features continuous automatic variable readout for any applied pressure within its range with an accuracy of one part in 3000. A traveling weight opposes and balances the applied pressure automatically from either an absolute or differential reference.—*Ideal-Aerosmith, Inc.*, 3913 *Evans Ave., Cheyenne, Wyo.*



CIRCLE 262 ON READER-SERVICE CARD



Thermo-hygrographs in 8", 10", 12" chart sizes. Dial Thermometers in 3½", 4½", 6", 8½" dial sizes.

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CORROSION MEASUREMENT PROBE

New Corrosion Measurement Probe which checks electrical resistance can detect the slightest change in humidity, ozone concentration, water content in non-aqueous liquid, or other environmental conditions which have a tendency to attack metal. The essential element of the probe is a vacuum-deposited film of metal, 2 to 50 millionths of an inch thick. As the instrument connected to the probe can detect as little as five billionth of an inch of metal loss, the concentration of the corrosive compound can be extremely small, yet quickly detected.—*Thompson Ramo Wooldridge Inc.,* 8433 *Fallbrook Ave., Conoga Park, Calif.*

CIRCLE 263 ON READER-SERVICE CARD

VITON-FACED PLUG VALVES

New Eccentric Valves, through 6" size, with Viton-covered plugs provide a dead tight shutoff on highly corrosive liquids, gases, and slurries. The physical properties of Viton make it an ideal plug facing material. It does not cold flow, it is highly resilient, and on some services it can be used to 350°F.—*DeZurik Corp., Sartell, Minn.*

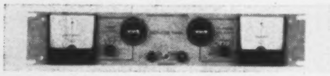
CIRCLE 264 ON READER-SERVICE CARD

TAPE-READER SPOOLER

New Model 4533 Spooler unit takes up 300 ft of punched paper or Mylar tape. 6"-dia reel unit can be used with standard Dykor photo-electric readers for speeds up to 300 characters/sec if fast stop requirements are to be met.—*Dykor Tape Reader Div., Digitronics Corp., Albertson, L. I., N. Y.*

CIRCLE 265 ON READER-SERVICE CARD

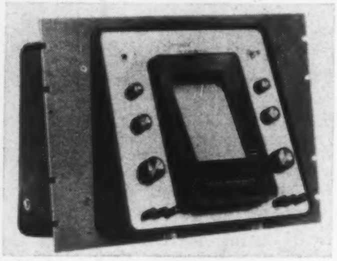
MANUAL DIGITAL VM



New Monitor Panel, Model ENO-2, for high accuracy strain gage instrumentation which reads bridge excitation voltage and bridge unbalance to a 0.1% accuracy, uses an ultra-stable zener-diode regulated supply. Meter marked "Balance" is used to set the zero output level of a strain gage bridge. In static tests, however, this instrument can also be used as a strain indicator. It gives a direct reading (in mv) of the unbalance which the gage has experienced during the test. Thus the instrument performs as a manual, digital voltmeter. —*Video Instruments Co., Inc.,* 3002 *Pennsylvania Ave., Santa Monica, Calif.*

CIRCLE 266 ON READER-SERVICE CARD

ADAPTER PANEL



New Adapter Panel for the portable 2-channel Recorder, Mark II, is designed for mounting in a standard 19" rack, which does not affect its portability.—*Brush Instruments, 37th and Perkins, Cleveland* 14, *Ohio.*

CIRCLE 267 ON READER-SERVICE CARD

COATED RESISTANCE WIRE

New resistance-alloy Wire with a dual-layer, high temperature insulation of Ceron, (ceramic plus Teflon) is capable of operating continuously at temperatures of 250°C, and up to 300°C for short periods. The combination offers also excellent solvent resistance. Ceron is a trademark of Sprague Electric Co.—*Kanthal Corp., Amelia Place, Stamford, Conn.*

CIRCLE 268 ON READER-SERVICE CARD

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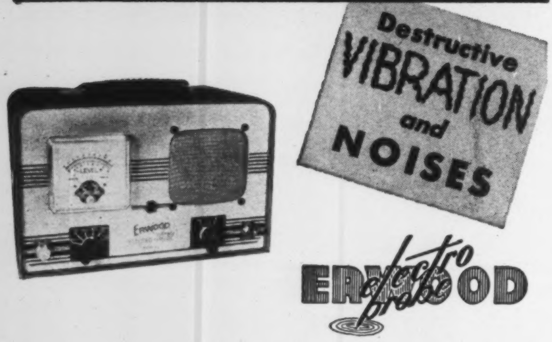

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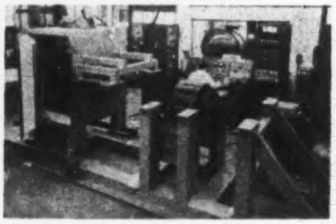
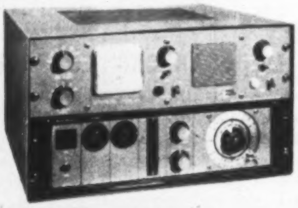


and any altitude from earth level to 200,000 ft while vibrating missile assemblies or components. Test space is 8 cu ft.—*Itemlab, Inc., 18 Beechwood Ave., Port Washington, N. Y.*

CIRCLE 269 ON READER-SERVICE CARD

SCALER RATEMETER

New Model 555 Scaler Ratemeter combines an advanced scaler, precision-ratemeter, integral-analyzer, spectrometer-quality high voltage supply, and audible clicker-howler.



Operating with any Geiger or scintillation detector, it provides in one compact package all basic elements needed for medical isotope work. Features include simultaneous digital and analog displays.—*Baird-Atomic, Inc., 33 University Rd., Cambridge 38, Mass.*

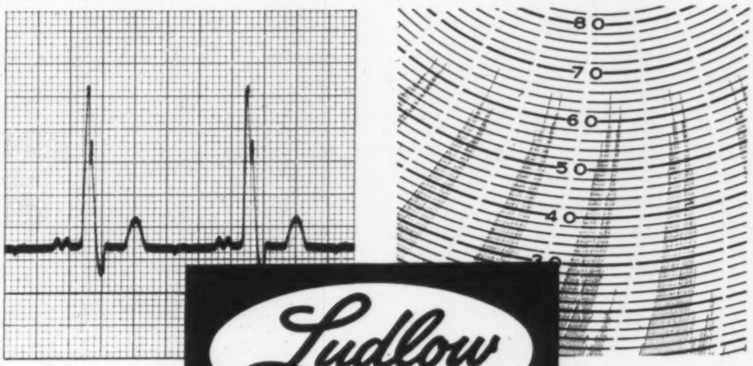
CIRCLE 270 ON READER-SERVICE CARD

CODEWRITER

New Codewriters, a group of electronic data input and output machines, which print characters serially, are capable of discrete line or

binary connection to the basic data handling unit or media creation equipment. Both alpha-numeric and numeric-only printouts are available. —*Royal McBee, Industrial Products Div., 740 N. Main St., West Hartford 17, Conn.*

CIRCLE 271 ON READER-SERVICE CARD



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CONTROL UNIT FOR ENVIRONMENTAL CHAMBERS

New integrated Control Unit for low-temp high-temp chambers using liquid CO_2 for cooling features plug-in connections for temperature controller, fan motor, and heating circuit, which is an independent circuit operating through a heavy duty relay.—*Development Engineering Co., Inc.,* 9 *Cross St., Norwalk, Conn.*

CIRCLE 272 ON READER-SERVICE CARD

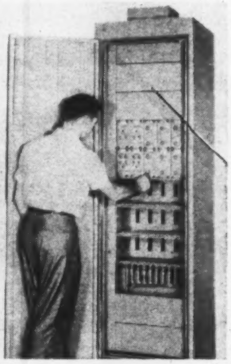
MODULAR OSCILLOGRAPH

New Modular Oscillograph, Type 5-123, affords a variety of configurations by combining mounting, record transport, optical, drive, and front panel controls. 36 and 50 channels are basic. Record speeds range from "very slow" to 160"/sec. 12" direct-print-out paper is standard.—*Consolidated Electrodynamics Corp.,* 360 *Sierra Madre Villa, Pasadena, Calif.*

CIRCLE 273 ON READER-SERVICE CARD

ELECTRIC SYSTEMS CABINETS

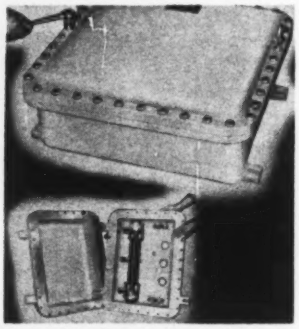
New standard Cabinets are suited to house digital data processing equipment, analog computing circuits, and electric process control, all in the same standard cabinet. Modular components are plugged into a wiring plane. Product Spec G71-6 gives details.—*Bailey Meter Co.,* 1050 *Ivanhoe Rd., Cleveland* 10, *Ohio.*



CIRCLE 274 ON READER-SERVICE CARD

EXPLOSION-PROOF HOUSINGS

New cast-aluminum-alloy Explosionproof Housings, tested at pressures up to 275,000-lb force exerted against the cover, are UL approved in Class I, Group D, and Class II, Groups E, F, and G, hazardous locations. In addition they will not rust, are non-magnetic, non-sparking, and are light in weight. Flanged surfaces are ground flat to 0.0015", and do not utilize gaskets. Bulletin 160 gives details.—*Adalet Mfg. Co., 14300 Lorain Ave., Cleveland 11, Ohio.*



CIRCLE 275 ON READER-SERVICE CARD

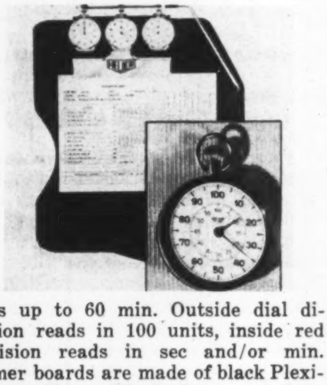
POCKET REFRACTOMETERS

New line of Refractometers gives a quick and convenient means of determining sugar and starch content, total protein in serum, and refractive index of liquids. Models available: 0-32% and 30-60%, soluble solids, and triple-range model 0-90% (divided range 0-43%, 41-73%, and 71-90%). Special starch model 0-27% for sizing and starch content. Weight: approx. 9 oz. Write for literature.—*Kernco Instruments Inc., Box 1284, Church St. Sta., New York 8, N. Y.*

CIRCLE 276 ON READER-SERVICE CARD

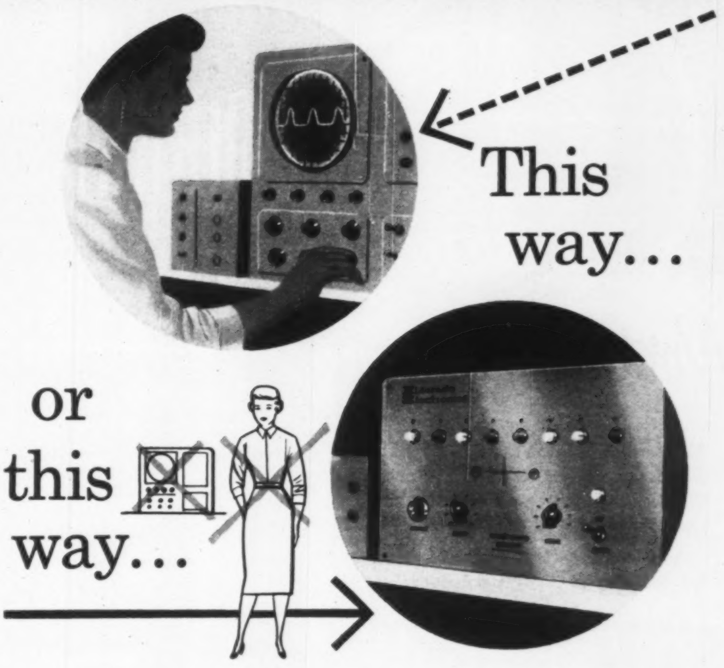
DECIMAL TIMER BOARD

New Century Decimal Timer features Incabloc jeweled shock-protection, unbreakable mainspring, and 7 jewels. Large red minute hand registers up to 60 min. Outside dial division reads in 100 units, inside red division reads in sec and/or min. Timer boards are made of black Plexiglass.—*Heuer Timer Corp., 441 Lexington Ave., New York 17, N. Y.*



CIRCLE 277 ON READER-SERVICE CARD

How Do You Measure and Sort?



This way...
or this way...

...with Digital Display

Here are two ways of presenting accurate measurement information. One requires a scope and a skilled operator. The other—an Eldorado system—gives the result in easily read digital form. The Eldorado system can be used by unskilled personnel to give more accurate results at lower costs and, since it is a digital system, it can be adapted to automatic control production or test processes.

Two Typical Functions of Eldorado Systems:

1 **Analysis as to Size.** Eldorado has basic circuits which analyze pulse height. All that is required is a transducer capable of feeding pulses proportional to size of the physical phenomena to be measured and sorted.

2 **Analysis as to Time.** Other Eldorado systems accurately count and store the number of events occurring in any number of discrete and consecutive time intervals. Again, the only other component needed aside from the system is a transducer.

NOTE: Each Eldorado system is designed for a specific application. Eldorado will be happy to discuss yours in detail. Contact your Eldorado representative, or write us direct. You'll have a quick answer.

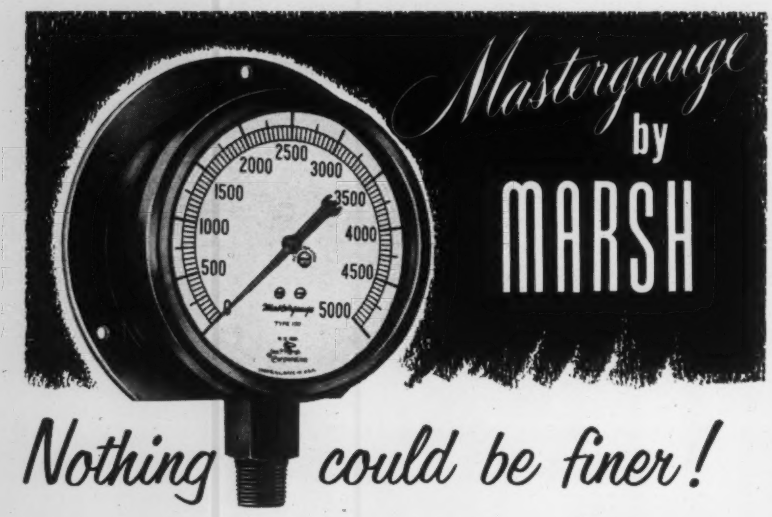
17

Please address Dept. 35-3

Eldorado Electronics

2821 TENTH STREET • BERKELEY 10, CALIFORNIA

CIRCLE 120 ON READER-SERVICE CARD



MARSH
Write for catalog

Mastergauge alone brings you "Conoweld" leakproof, one-piece tubing and socket; sturdier Marshalloy case; precision mastergauge movement; stainless tube and socket when required.

Mastergauge is standard bearer for the broad line of Marsh Gauges for every service.

MARSH INSTRUMENT COMPANY, Dept. 42, Skokie, Ill.
Division of Colorado Oil and Gas Corporation
Marsh Instrument & Valve Co. (Canada) Ltd., 8407 103rd St., Edmonton, Alberta
Houston Branch Plant, 1121 Rothwell St., Sect. 15, Houston, Texas

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Schlieren Systems
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HEUER
IMPROVES
STOPWATCH
LEGIBILITY BY
85%

New Central Register design improves legibility over all other Timers. Heuer Century Decimal Timer

Heuer's
exclusive features:
1. Doubled register capacity—red center hand registers up to 60 minutes.
2. Smart black nonreflecting finished cases—twice as hard as standard chrome.
3. Incabloc jeweled shock-protection and unbreakable mainspring.

Remarkably low $25.00 Ref. 33.213
Timer Boards from $10
GUARANTEED REPAIR SERVICE
on all fine timing instruments
FREE estimates
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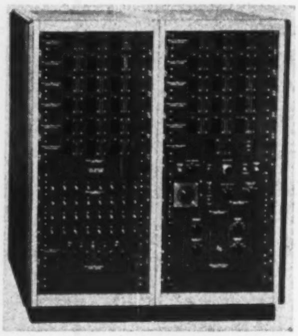
CIRCLE 123 ON READER-SERVICE CARD

100
10
20
30
40
50
60
70
80
90
HEUER

TIME ANALYZER SYSTEM

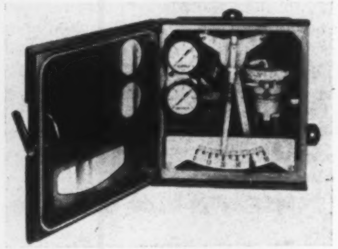
New 32-channel Time Analyzer System 0900, accurately counts and stores digital information in 32 consecutively gated channels. Channel scalers have a double-pulse resolution of 1 μsec. Channel widths are variable from 1 μsec to 0.08 sec. Each of the 32 channels has two electronic counting units and a 4-digit mechanical register to provide storage of 10^6 digits.—*Eldoradŏ Electronics,* 2821 *Tenth St., Berkeley* 10, *Calif.*



CIRCLE 278 ON READER-SERVICE CARD

INDICATING CONTROLLER

New A/D (Advanced Design) Indicating Pneumatic Controller features frequency response curves flat to 400 cpm (proportional) and 325 cpm (proportional + reset); a proportional band continuously adjustable from 400-0% (with reset rate adjustable from 0.1 to 50 repeats/min); and excellent temperature stability, insured by a Ni-Span C feedback bellows.—*Bristol Co., Waterbury* 20, *Conn.*



CIRCLE 279 ON READER-SERVICE CARD

ROUND CHART REC/CONT

New round-chart null-balance potentiometer-type Recorder features interchangeability of most of its components with those of existing G-E strip-chart models. Minimum accurate scale span is one mvdc. Response times available are 4, 10, and 24 sec full scale. A zener diode offers a constant voltage reference accurate to ±0.05%. The control portion features trip switch cams that are individually adjustable.—*General Electric Co., Schenectady* 5, *N. Y.*

CIRCLE 280 ON READER-SERVICE CARD

REPETITIVE OPERATION ANALOG COMPUTER

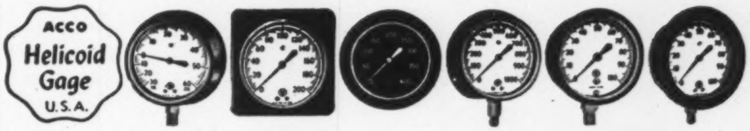
New High Speed Repetitive Operation accessory for PACE 231R analog computers provides problem solution as a continuous plot on the 17" display screen. The effect of a change in problem variables can be observed immediately on the display screen. When the optimum design is reached, the computer may be switched back to real-time operation so permanent plots can be made of the final and more detailed solution. High Speed Repetitive Operation is particularly well suited to problems involving the simulation of servomechanisms, optimization of chemical, petro-chemical and physical systems, and the solution of boundary-value problems. Computing times of from 10 to 80 msec are available and may be controlled from either the ROC unit or the display unit. The display unit consists of four chassis units and allows simultaneous viewing of 8 problem variables plotted against time or 7 variables plotted against an eighth on the 17" screen. In the display unit, 21 voltage calibration lines are references to computer voltage within 0.1%. Time lines are generated by a crystal oscillator to 0.05%.—*Electronic Associates, Inc. (EAI), Long Branch, N. J.*

CIRCLE 281 ON READER-SERVICE CARD

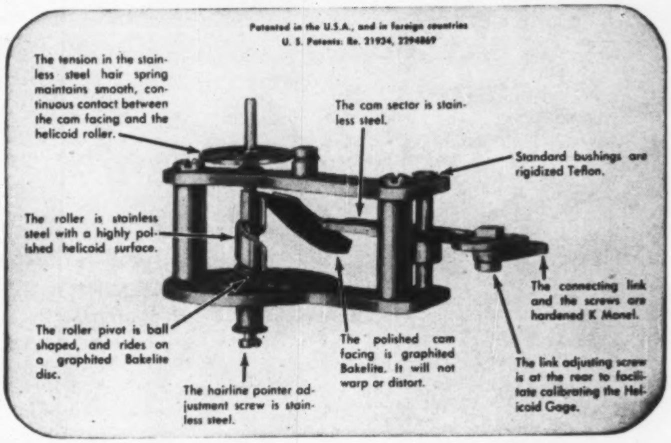
RESISTOR MATERIAL

New low-density Resistor Alloy 815-R features high electrical resistivity (815 ohms/cmf at 20°C) and a low temperature coefficient of resistance which is controlled within guaranteed limits of ±0.00001 ohm/ohm/°C ±10ppm). Basically a modified iron-chromium-aluminum composition containing small percentages of several other elements, its resistance to corrosion is claimed to be vastly superior to other similarly composed materials. Other features are: excellent ductility, high tensile and yield strengths, and exceptionally high resistance to wear and abrasion. Its high resistivity and low temperature coefficient are controlled *in the melt* not established by subsequent "aging" treatments as is the case with nickel-chromium resistor alloys. Available precision-drawn to standard wire sizes ranging from 0.0031" (40 gage) down to and including 0.0005" dia.—*Hoskins Mfg. Co., 4445 Lawton Ave., Detroit 8, Mich.*

CIRCLE 282 ON READER-SERVICE CARD



ACCO
Helicoid
Gage
U.S.A.



Patented in the U.S.A., and in foreign countries
U. S. Patents: Re. 21934, 2294869

The tension in the stainless steel hair spring maintains smooth, continuous contact between the cam facing and the helicoid roller.

The cam sector is stainless steel.

Standard bushings are rigidized Teflon.

The roller is stainless steel with a highly polished helicoid surface.

The connecting link and the screws are hardened K Monel.

The roller pivot is ball shaped, and rides on a graphited Bakelite disc.

The polished cam facing is graphited Bakelite. It will not warp or distort.

The link adjusting screw is at the rear to facilitate calibrating the Helicoid Gage.

The hairline pointer adjustment screw is stainless steel.

Exclusive Helicoid movement provides...
Sustained Accuracy... on the toughest jobs

- Helicoid Gages have no gears, no teeth, reducing wear to an absolute minimum. No danger of fouling, either—rolling action of cam facing keeps contact surface clean. Helicoid Gages have been tested through 75,000,000 cycles, with virtually no wear or loss of accuracy, while conventional geared gages became useless after 500,000 cycles.

Helicoid Gages give *sustained* accuracy even when subjected to violent pressure pulsations or mechanical vibrations. Pointer can be set externally, without removing glass, and cannot be jarred out of position. Dial faces are easy to read, won't corrode or chip. A full range of Helicoid Gages is available for any application. Next time, specify Helicoid—the gage that *stays* accurate.

Bourdon Tubes won't Stretch, Leak, or Crack

Helicoid Bourdon tubes are made from seamless tubing, and are designed for maximum torque and minimum stress. At the factory, each tube is individually tested, overpressured, and stress relieved. Four materials—alloy steel, K Monel, stainless steel, and phosphor bronze—are available to meet applications ranging from tap water to almost any acid.

NEW! Solid-Front Safety Case Gives Added Protection

The new Helicoid solid-front case diverts the force of a burst in a backward direction, away from the operator. The force escapes by deforming, though not detaching, the back cover plate. Helicoid Gages are also available in phenol, acaloy flanged, acaloy flangeless, polished flangeless, round flush, polished flush ring, and square flush cases.

WRITE for details

Ask for Catalog DH-65

HELICOID GAGES

ACCO

Helicoid Gage Division • American Chain & Cable Company, Inc.
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CIRCLE 124 ON READER-SERVICE CARD

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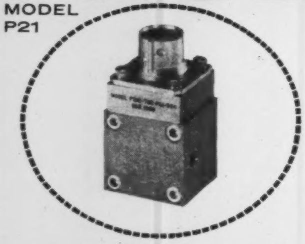
**Machine tools to be shown at European Machine Tool Show, Hanover, September 11-20, 1960*

CIRCLE 125 ON READER-SERVICE CARD

PACE

MODEL
P21



magnetic reluctance

PRESSURE
TRANSDUCER

Ranges: 1 to 1,000 psi — Gage, Differential or Absolute.

Pressure Media: Corrosive liquids and gases, both sides.

Insensitive to Shock and Vibration — Not oil filled.

Withstands Extreme Overpressure.

PACE's P21 Transducer (only 1 3/32" square) is miniaturized for missile, rocket and aircraft flight installations.

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MICO *Precision Apparatus*

HEAVY DUTY 2 & 3 DIMENSIONAL ENGRAVER

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2-75 Centimeter Range

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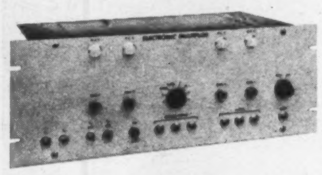
CIRCLE 127 ON READER-SERVICE CARD

MULTIPLIER/DIVIDER

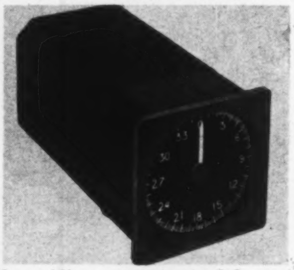
New wide-bandwidth (350kc), Model MU-500E, Multiplier-Divider is virtually the direct instrumentation of the mathematical identity: $xy = \frac{1}{4}[(x+y)^2 - (x-y)^2]$. Chopper-stabilized sum-and-difference amplifiers, precision reference voltage supplies and precision components are used throughout. Solution time is less than 2 μsec, phase shift is 1° at 12 kc, accuracy is 0.25% full scale, and output range is ±50 v at ±10 ma.—*GPS Instrument Co., Inc.,* 180 *Needham St., Newton* 64, *Mass.*



CIRCLE 283 ON READER-SERVICE CARD

DIG/AN INDICATOR

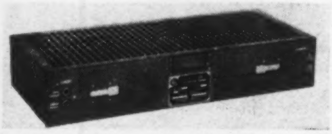
New Digital-to-Analog Converter Indicator in the line of computer subsystems, consisting of a relay matrix, a 2^9 an/dig converter, and a 400-cps/115-v motor, has a read-in of pure binary information. Analog output of 360° on a dial features minor arc sensing. Characteristics include ±½° accuracy; 52-ma input current, and 8-rpm max. output rate.—*Kearfott Co., Inc.,* 1500 *Main Ave., Clifton, N. J.*



CIRCLE 284 ON READER-SERVICE CARD

FREQUENCY SHIFT TERMINAL

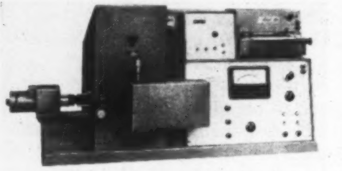
New Model 1726 High Speed Data Transmission Terminal is a frequency shift terminal designed for the transmission of data at speeds up to 7000 bits/sec which can be directly applied to microwave equipment or open-wire telephone circuits. 21 standard channels, providing a rate of 2400 bits/sec are available for 20 to 110 kc. Five 7000-bits/sec channels are available from 50 to 110 kc.—*Radio Frequency Labs., Inc., Powerville Rd., Boonton (Twp), N. J.*



CIRCLE 285 ON READER-SERVICE CARD

EMISSION SPECTROPHOTOMETER

New Model 151 Emmission Spectrophotometer is an integrated electromechanical-optical system which records in angstroms spectral radiant

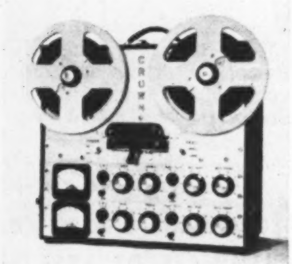


flux density from ultraviolet to infrared. High sensitivity photomultipliers are used in conjunction with Bausch & Lomb grating monochromator. Bulletin I & E Spectro 151 gives details. —*Land-Air, Inc., Instrument & Electronic Div., 2133 Adams Ave., San Leandro, Calif.*

CIRCLE 286 ON READER-SERVICE CARD

STEREO RECORDER

New 714 C, Stereo X, records and plays 4-track stereo, plays 2-track stereo, and is capable of recording

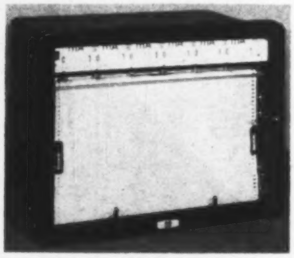


and playing monaural. Features include 3 speeds, 3 motors, accepts 10" reels, 4 microphone inputs, rack mount, and automatic stop.—*Crown International, Elkart, Ind.*

CIRCLE 287 ON READER-SERVICE CARD

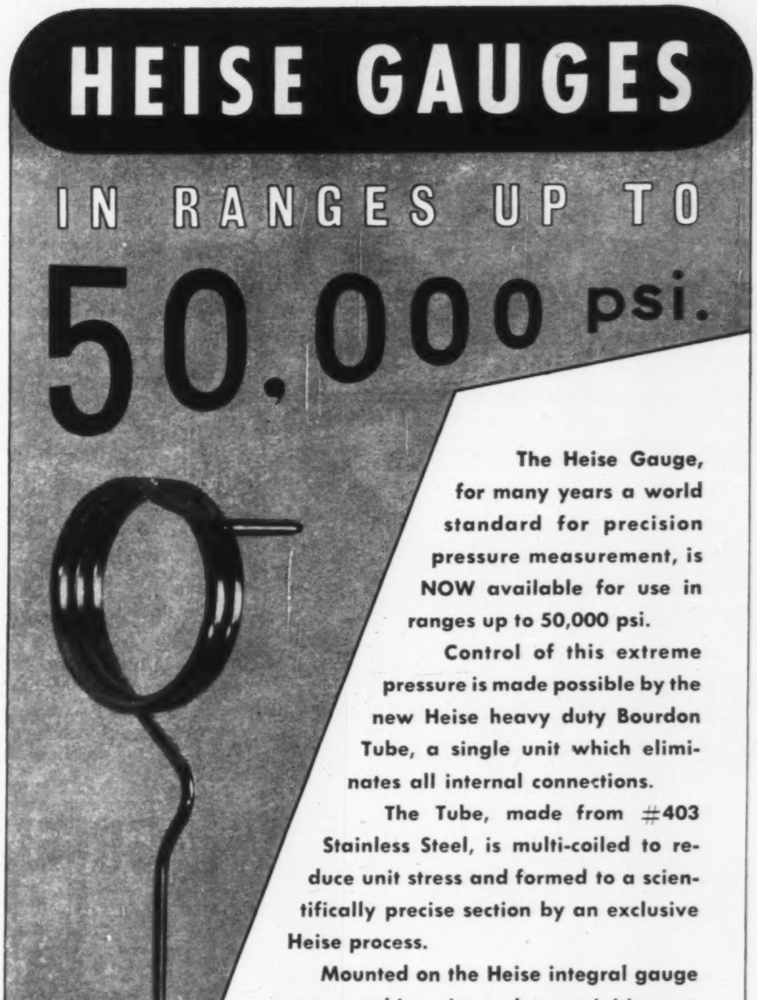
RECTILINEAR STRIP CHART RECORDER

New rectilinear strip chart recorder provides six independent non-overlapping and continuous records of



volts, milliamps or other variables available as outputs from electrical or electronic systems. Sensitivity is 1 ma full scale; response time is 1.0 sec. Chart speeds available are from ½"/hr to 24"/min.—*Curtiss-Wright Corp., Princeton Div., Princeton, N. J.*

CIRCLE 288 ON READER-SERVICE CARD



HEISE GAUGES

IN RANGES UP TO

50,000 psi.

The Heise Gauge, for many years a world standard for precision pressure measurement, is NOW available for use in ranges up to 50,000 psi.

Control of this extreme pressure is made possible by the new Heise heavy duty Bourdon Tube, a single unit which eliminates all internal connections.

The Tube, made from #403 Stainless Steel, is multi-coiled to reduce unit stress and formed to a scientifically precise section by an exclusive Heise process.

Mounted on the Heise integral gauge movement this unique element initiates a new concept in pressure gauge design.

The 50,000 lb. gauge features the traditional high quality workmanship expected of all Heise equipment.

Accuracy is held to 1/10 of 1% of full scale reading in this ultra high pressure laboratory instrument.

PRESSURE RANGES	DIAL SIZES	PRICES	DELIVERY
15 to 50,000 P.S.I.	8½"-12"-16"	from $166.75	within 30 days

HEISE BOURDON TUBE COMPANY, INC.
BROOK ROAD, NEWTOWN, CONNECTICUT, U.S.A.

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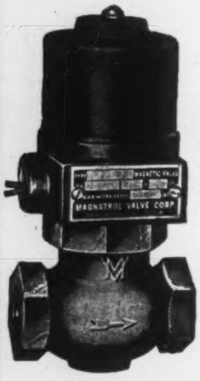
Eliminate

Costly Flow Failures



Magnatrol

SOLENOID VALVES

Quick Operating *Non Sticking* *Tight Seating*

These three design advantages are your assurance against costly flow failures. Attain dependable, accurate, automatic or remote control of liquids or gases with **Magnatrol Valves.** Installed quickly and easily in connection with . . . flow-meters, thermostats, float and time switches. Every Magnatrol Valve is delivered to you—factory tested—guaranteed free from defects in material and workmanship.

Available in normally closed or normally open models. Pressure ranges from zero up to 300 PSI. Voltages to 575.

Catalog containing complete specifications mailed upon request.

Magnatrol **VALVE Corp.**
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BARIUM TITANATE
BISMUTH
BRASS
CARBORUNDUM
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COBOLT FERRITE
COPPER
*CORNING 707
*CORNING 7052
CUPROUS BROMIDE
FERRITE
FERROX
**FLUORIDE, CALCIUM
**FLUORIDE, LITHIUM
GALLIUM ANTIMONIDE
GALLIUM ARSENIDE
GARNET
GERMANIUM
GOLD

INDIUM ANTIMONITE
INDIUM PHOSPHIDE
INDOX
IRON SINGLE CRYSTAL
LITHIUM FERRITE
MAGNETIC PLUMBITE
MELAMINE FIBER GLASS
MICA, SYNTHETIC
NICKEL OXIDE
PLATINUM
POTASSIUM BROMIDE
*PYREX
*QUARTZ, CRYSTAL
*QUARTZ, FUSED
**SAPPHIRE
**SODIUM CHLORIDE
**STEEL
STRONTIUM TITANATE
TEFLON
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*VYCOR
*X-RAY LEAD GLASS
ALL TYPES KNOWN GLASS

* Carried in stock
** Purchased for orders

CIRCLE 130 ON READER-SERVICE CARD

ICS PEOPLE IN THE NEWS

MINNEAPOLIS-HONEYWELL announces organizational changes in which Vice President *Henry F. Dever,* head of the Industrial Products Group, transfers from Philadelphia to company headquarters in Minneapolis. *James S. Locke,* newly elected corporate vice president, becomes vice president and general manager of Brown Instruments Division. He will be responsible also for operation of the Valve Division in Fort Washington, Pa. and the Fall River, Mass. Division. Locke succeeds *C. L. Peterson,* who becomes vice president of the company's central region, directing sales there, with headquarters in Cleveland.

J. S. LOCKE
M-H

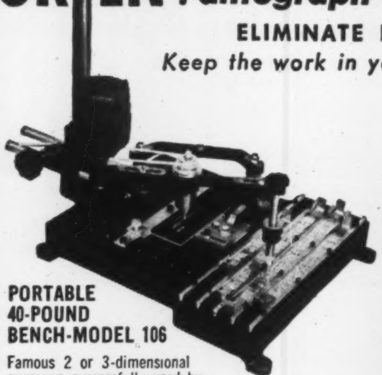
M. A. EDWARDS
GE

GE announces that *Dr. Martin A. Edwards,* engineering manager of the Electric X-Ray Department in Milwaukee, has been appointed manager of the newly established Advanced Product Planning Operation of the Electronic Components Div., Owensboro, Ky.

GREEN *Pantograph Engravers*

ELIMINATE DELAYS!

Keep the work in your own plant.

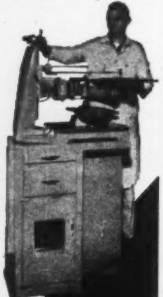


PORTABLE 40-POUND BENCH-MODEL 106

Famous 2 or 3-dimensional engraver, successfully used by thousands, features 5 positive, accurate pantograph ratios. Versatile ball bearing spindle has three speeds up to 14,000 rpm; height of pantograph and position of cutter are continuously adjustable; one copy carrier (supplied) accepts all standard master type sizes.

The Model 106 has proven incomparable for speed and accuracy . . . yet reasonably priced.

Cutter grinders, rotary tables, master letters, compound slides, name plates and all required accessories. For complete information, write to



MODEL D2
HEAVY-DUTY
2-DIMENSIONAL

- 575 pounds — rigid, sturdy, precise
- Vertical adjustment of copy table automatic with Pantograph
- Unobstructed on three sides to take large work
- Micrometer adjustment for depth of cut
- Ball-bearing construction throughout super-precision ball bearing spindle
- Spindle speeds up to 26,000 rpm for engraving or machining modern materials
- Ratios 2 to 1 to infinity master copy area 26" x 10"
- Vertical range over 10"

GREEN INSTRUMENT COMPANY, INC.

383 PUTNAM AVENUE, CAMBRIDGE 39, MASS.

CIRCLE 131 ON READER-SERVICE CARD

DIGITAL EQUIPMENT CORP. announces that its president, *Kenneth H. Olsen* has been honored as a "Young Electrical Engineer of 1959" by Eta Kappa Nu.

K. H. OLSEN
Digital Equipment

E. M. FEELEY
Trinity

TRINITY EQUIPMENT CORP. announces that *Edward M. Feeley* has been appointed president of the corporation's wholly-owned subsidiary **TRINCOR CORP.**

KEINATH INSTRUMENT CO. has been incorporated in Columbus, Ohio to design and manufacture recorders including the Keinath sweep-balance recorder. President is *W. E. Van Horne,* formerly with Industrial Nucleonics. *Dr. George Keinath* of Larchmont, N. Y., formerly chief engineer of Siemens & Halske, Berlin is consulting technical director.

PHOTOVOLT CORP. announces that *Dr. Bela A. Silard* has been elected its new president, following the sudden death of *Dr. Fritz Lonberg.*

ELECTRONIC COUNTERS, INC. has purchased the electronic counter business from Potter Instrument Co. *N. A. Moerman,* formerly vice president in charge of engineering at Potter has become president of the new company.

NBS announces that *Benjamin L. Page* has been appointed chief of the Length Section, Optics and Metrology Div.

NEW PLANTS AND MERGERS

CHANCE VOUGHT AIRCRAFT is acquiring 80% interest in **INFORMATION SYSTEMS, INC.** which, in turn, is taking over the operating assets of **PANELLIT, INC;** also of **GENESYS CORP.**, a wholly owned Chance Vought subsidiary, as a separate operating unit. ISI headquarters with *Al Sperry* as chairman of the board and technical director will be moved to Los Angeles. The Panellit Div. will continue to operate in Skokie, Ill.

IRRADIATED INSULATIONS, INC. has been formed by **CARLISLE CORP.** and **RADIATION APPLICATIONS, INC.** to produce insulated wire for special requirements in the electronics, aviation, and missile fields. RAI will provide the research staff and facilities, and Carlisle is adding the production, engineering, and marketing experience of its subsidiary *Tensolite Insulated Wire Co.*

ROBERTSHAW-FULTON has acquired the Microsen line from Manning, Maxwell & Moore and will integrate these instruments with the industrial products of the Aeronautical and Instrument Division. A number of M, M & M instrument division engineers, scientists, and sales people are joining Robertshaw's Anaheim division.

PHILADELPHIA
THERMAL CONTROLS AND THERMOMETERS

Specify! THE BEST

A half century of experience is back of every instrument we make. You get assured accuracy and long dependable performance when you specify "Philadelphia." Our specialized staff will be glad to discuss your problem in our field.

SEND FOR CATALOG 110

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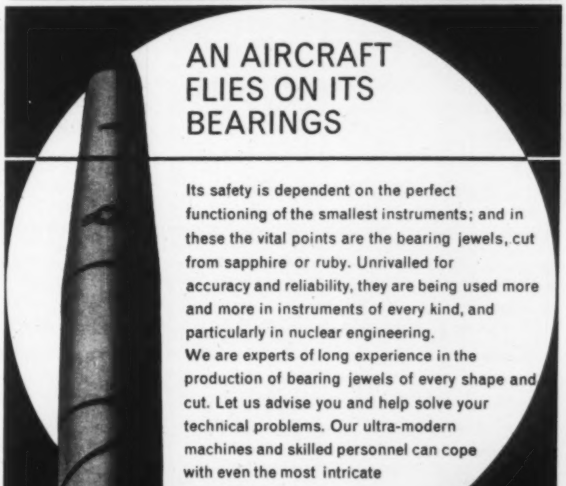
CIRCLE 132 ON READER-SERVICE CARD



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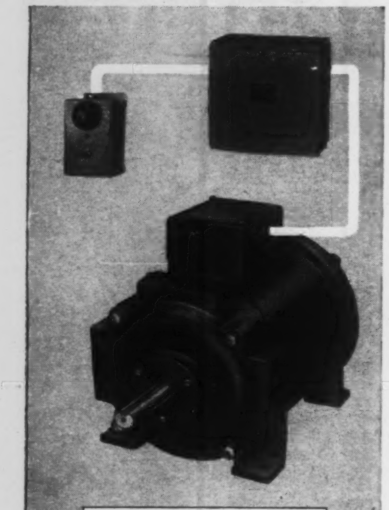

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ADJUSTABLE-SPEED DRIVES

○ **SPEED RANGE** Infinitely adjustable from less than 36 rpm to more than 3600 rpm while delivering full rated torque. Continuous duty rating at all speeds.

○ **REGULATION** Both line and load regulation is better than ½ of 1% of rated speed.

○ **HORSEPOWER** Various models from ¾ hp down to 1/200 hp. Motors of ¼ hp and larger are totally enclosed.

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CIRCLE 134 ON READER-SERVICE CARD

ICS NEW LITERATURE

CONTROL SYSTEMS, CONTROLLERS

PRESSURE CONTROLLERS. 2-page Product Specification P41-2 illustrates and specifies Type B41 pneumatic controller for pressures to 170 psig and differentials from −30" to +30" WC. —Bailey Meter Co., 1050 Ivanhoe Rd., Cleveland 10, Ohio.

CIRCLE 289 ON READER-SERVICE CARD

SEQUENCE CONTROLLER. 2-page Bulletin on a new sequence controller SC-500 outlines advantages of this electrical control unit.—Warco Industries, 6625 Delmar Blvd., St. Louis 30, Mo.

CIRCLE 290 ON READER-SERVICE CARD

ELECTRIC CONTROLLERS. 56-page Catalog illustrates and describes more than a hundred types of pressure, temperature, level, mechanical movement controllers, etc.—Mercoid Corp., 4201 Belmont Ave., Chicago 41, Ill.

CIRCLE 291 ON READER-SERVICE CARD

RECORDER/CONTROLLER. 4-page Bulletin GEZ-2969 describes features, application, measurable parameters, and specs of round-chart single- and double-pen recorders.—General Electric Co., Schenectady 5, N. Y.

CIRCLE 292 ON READER-SERVICE CARD

FUEL CUT-OUT & ALARM CONTROL. 2-page Catalog Section D2.5-6 illustrates and describes new boiler safety device.—Reliance Gauge Column Co., 5902 Carnegie Ave., Cleveland 3, Ohio.

CIRCLE 293 ON READER-SERVICE CARD

HYGROMETRY. 68-page Catalog 660 covers humidity measuring and control systems and instruments.—Hygrodynamics, Inc., 8030-8050 Georgia Ave., Silver Spring, Md.

CIRCLE 294 ON READER-SERVICE CARD

VALVES, ACTUATORS

ELECTRIC MOTOR ACTUATORS. 2-page Product Data Sheet 6 provides technical information on models EM 25 and EM 150 electric motor actuators for ball valves.—Jamesbury Corp., Worcester, Mass.

CIRCLE 295 ON READER-SERVICE CARD

POSITIONING AND PROGRAM CONTROLLERS. 16-page Bulletin J-105 describes linear and rotary actuators for positioning and programming.—Jordan Controls, Inc., 3235 West Hampton Ave., Milwaukee 9, Wis.

CIRCLE 296 ON READER-SERVICE CARD

REGULATORS. 4-page Condensed Catalog 60 contains pictures and descriptions of pressure-and temperature-regulators, float valves, flow control valves, safety- and relief-valves, and strainers.—O. C. Keckley, 3400 Cleveland St., Skokie, Ill.

CIRCLE 297 ON READER-SERVICE CARD

TWO-WAY VALVES. 8-page Bulletin 91022 describes in detail Series 20 two-way valves for air, oil, water, gas or chemical.—Airmatic Valve, Inc., 7313 Associate Ave., Cleveland 9, Ohio.

CIRCLE 298 ON READER-SERVICE CARD

PRESSURE

COMPENSATED PRESSURE GAGES. 4-page brochure describes automatic thermal compensator in precision pressure gages.—Heise Bourdon Tube Co., Inc., Brook Rd., Newtown, Conn.

CIRCLE 299 ON READER-SERVICE CARD

GAS DENSITY SWITCHES. Two 2-page technical data sheets describe and illustrate two gas density switches.—Newark Controls Co., 15 Ward St., Bloomfield, N. J.

CIRCLE 300 ON READER-SERVICE CARD

PRESSURE TRANSMISSION. 4-page Bulletin NR-10 describes Acragage electric transmission systems for remote pressure reading and maximum or minimum signals at one or more locations.—Instruments Div., of International Register Co., 2620 W. Washington Blvd., Chicago 12, Ill.

CIRCLE 301 ON READER-SERVICE CARD

ABS/DIFF MANOMETER. 4-page Bulletin B-1008-2 illustrates and describes Type E-1, Model 1070-C test manometer.—Ideal-Aerosmith, Inc., 3913 Evans Ave., Cheyenne, Wyo.

CIRCLE 302 ON READER-SERVICE CARD

PEAK PRESSURE GAGE. 4-page folder describes and illustrates a new hydraulic gage that indicates pressure peaks.—Hydel, Inc., 223 Crescent St., Waltham, Mass.

CIRCLE 303 ON READER-SERVICE CARD

TEMPERATURE

RESISTANCE THERMOMETER BULBS. 4-page Data File E1-6097 describes and specifies platinum wound resistance thermometer spirals.—Engelhard Industries, Inc., Instruments and Systems Div., 850 Passaic Ave., East Newark, N. J.

CIRCLE 304 ON READER-SERVICE CARD

WATER COOLED HI-TEMP PROBES. 2-page Bulletin 8.5 contains description and dimensional sketch of thermocouple type for gases.—Aero Research Instrument Co., Inc., 315 North Aberdeen St., Chicago 7, Ill.

CIRCLE 305 ON READER-SERVICE CARD

TEMPERATURE INDICATORS. 2-page Bulletin KC-871 describes thermistor temperature indicators.—Kahn and Co., Inc., Box 516, Hartford 1, Conn.

CIRCLE 306 ON READER-SERVICE CARD

FLOW, PUMPS

ROTAMETERS. 4-page Bulletin 150 gives details of materials used in rotameters for corrosive applications. —Brooks Rotameter Co., Hatfield, Penna.

CIRCLE 307 ON READER-SERVICE CARD

MAUSER **ELECTRIC GAGES**

- RAPID INSPECTION
- LOW INITIAL COST
- NO MAINTENANCE OR INSTALLATION COST

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CAT. #6551
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SIGNAL LIGHTS REPORT ACCURATELY WITHIN 20 MILLIONTHS OF AN INCH OVER AND UNDERSIZE AS WELL AS CORRECT SIZE BY FLASHING OF GREEN, RED OR YELLOW LIGHT.

Cat. #6501	— Head only	$60
Cat. #6551	— Signal box	55
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Cat. #650	— Not shown — Dial indicator for use with #6501	30
Cat. #6502	— Not shown — Coupling to connect #6501 to #650	5

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CIRCLE 135 ON READER-SERVICE CARD

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CIRCLE 136 ON READER-SERVICE CARD

TALLY-COUNT®—*an electronic*

PREDETERMINING COUNTER

Standard 2-decade model:
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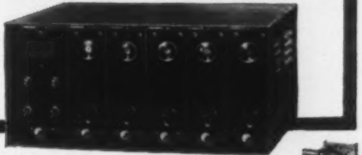

TALLY-COUNT is a versatile instrument, ideal for batch counting, packaging, unit flow and machine cycling. Tally-Count provides electronic speed and accuracy, at a price usually associated with electro-mechanical counters.

Plug-in decades (up to 5) $50 each

unique chassis design for plug-in sensing devices

A wide range of photoelectric and other sensing devices extends Tally-Count versatility. These devices plug into amplifiers, which can be incorporated as integral elements of the chassis. Tally-Count supplies all power for these sensing devices. No other power supply is needed.

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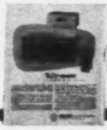

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CIRCLE 137 ON READER-SERVICE CARD

HELLER
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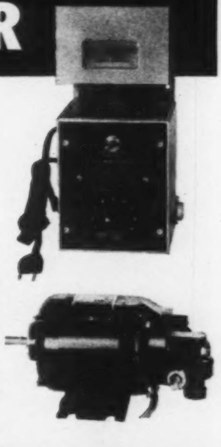
AC CONTROLLER
and matching
DC MOTOR



Complete, F.O.B., Las Vegas, Nevada **$84**

2T60 ELECTRONIC CONTROLLER with matching 1/50 H. P. DC MOTOR

SPECIFICATIONS

• Thyraton tube operated controller gives stepless operation • Input: 110-120 V., 60 cy. single phase • Output: 0-120 V., 200 ma. DC to armature • 1/50 H.P. ball bearing, right angle, gear head, shunt wound, DC motor • Reversible • Armature speed 0 to 4000 R.P.M. • Armature shaft is extended • Motors in gear ratios: 6, 18, 30, 36, 60, 100, 300, 540, and 1120:1 in stock.

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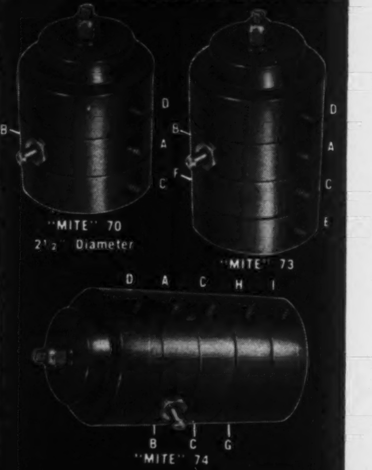
automatic or manual
trip or reset = "MITE"



The "MITE" is a snap-acting, adjustable pneumatic switch and/or relay.
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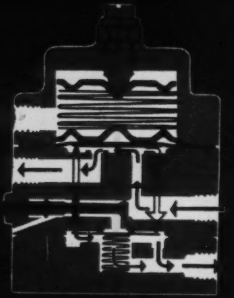

A – Air Signal Input
B – Signal Output (Lock-up on trip)
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E – Remote Pneumatic Reset
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G – TRIP TO OPEN (To "H")
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VALVES AND CONTROLS FOR THE COMMUNICATIONS, PROCESS AIRCRAFT AND MARINE INDUSTRIES

CIRCLE 139 ON READER-SERVICE CARD

ICS NEW LITERATURE

ROTAMETERS, FLOW INDICATORS 4-page Condensed Bulletin M-1 pictures and describes line of precision instruments for measuring, indicating, recording, and controlling flow rate of all types of fluids.—Schutte and Koerting Co., Instrument Div., Dept. M-R, Cornwells Heights, Bucks County, Penna.

CIRCLE 308 ON READER-SERVICE CARD

CONTROLLED VOLUME PUMPS. 4-page Bulletin 1153-c gives details and illustrations of Mersemetric pumps working against pressures to 1200 psig with accuracy better than 1%.—Milton Roy Co., 1300 E. Mermaid Lane, Phila. 18, Pa.

CIRCLE 309 ON READER-SERVICE CARD

PUMPS AND CONTROLS. 72-page Catalog 220 gives full design details and operating characteristics on line of hydraulic pumps, fluid motors, and valves.—Denison Engineering Div., American Brake Shoe Co., 1160 Dublin Rd., Columbus, Ohio.

CIRCLE 310 ON READER-SERVICE CARD

SPEED, COUNT

ELECTRIC TACHOMETERS. 4-page catalog describes and illustrates nine tachometer indicators and six electric generators for tachometer service.—Madison Electric Products, Inc., Madison, Ohio.

CIRCLE 311 ON READER-SERVICE CARD

PREDETERMINING COUNTERS. 4-page folder describes and illustrates several of the major types of mechanical, electromagnetic, and photoelectric counters incorporating the predetermining feature.—Veeder-Root Inc., Hartford 2, Conn.

CIRCLE 312 ON READER-SERVICE CARD

NUCLEONICS

GAMMA RADIOGRAPHY EQUIPMENT 4-page brochure tabulates specs of 16 types of radiography machines.—Radiation Engineered Services, Lafayette and Water Sts., Norristown, Penna.

CIRCLE 313 ON READER-SERVICE CARD

ELECTRON ACCELERATOR. 4-page December issue of Arco News describes the L-band linear accelerator.—Applied Radiation Corp., 2404 No. Main St., Walnut Creek, Calif.

CIRCLE 314 ON READER-SERVICE CARD

DIGITAL INSTRUMENTATION

WAVE ANALYZER SYSTEMS. 16-page Bulletin DB 9050a describes and illustrates automatic wave analysis for Fourier and spectral power studies.—Minneapolis-Honeywell, Industrial Systems Div., 10721 Hanna St., Beltsville, Md.

CIRCLE 315 ON READER-SERVICE CARD

versatile PULSE RATE
Waugh FR-211 FREQUENCY-TO-DC CONVERTER

INPUT
FLOW SENSOR
TACHOMETER
PHOTO CELL
ELECTRO-MAGNETIC COIL
OTHER TRANSDUCERS

OUTPUT
DIGITAL COUNTER
POTENTIOMETER
OSCILLOGRAPH
PANEL METER
TAPE RECORDER

The Waugh FR-211 is a frequency-to-D.C. converter, producing D.C. voltages which are precisely proportional to the frequency of the A.C. input signal. Output may be read directly from a built-in panel meter, and output voltages are suitable to operate a wide variety of electronic indicators, recorders and controllers. The FR-211 has applications for critical measurements in the laboratory, as well as missile, chemical and petroleum fields.

GENERAL SPECIFICATIONS
Linearity: Within ±0.1%
Long Term Stability: ¼%
Input Voltage Range: 5 mv. to 10v RMS
Input Frequency Range: 5 to 3000 cps.
Output Impedance: 250 to 1000 ohms

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CIRCLE 140 ON READER-SERVICE CARD

TAPE TRANSPORT. 4-page Brochure 1618 describes Type 5-681 digital tape recorder/reproducer transport.—Consolidated Electrodynamics Corp., 360 Sierra Madre Villa, Pasadena, Calif.

CIRCLE 316 ON READER-SERVICE CARD

PAPER TAPE ACCESSORIES. 2-page Data Sheet AS-119 describes three new paper tape accessories for the Bendix G-15 digital computer.—Bendix Computer Div., 5630 Arbor Vitae St., Los Angeles 45, Calif.

CIRCLE 317 ON READER-SERVICE CARD

MEMORIES. 4-page Bulletin DF115.1 describes a series of general-purpose high-speed memories.—Telemeter Magnetics, Inc., Box 329, Culver City, Calif.

CIRCLE 318 ON READER-SERVICE CARD

DATA SEARCHER. 2-page Bulletin 2A-23833 describes and illustrates search and control system for tape recorders. —Electronic Engineering Co. of Calif., 1601 E. Chestnut Ave., Santa Ana, Calif.

CIRCLE 319 ON READER-SERVICE CARD

DATA PROCESSING EQUIPMENT. 4-page Bulletin S1159 describes all-solid-state electronic data processing equipment custom-tailored for various commercial applications.—Dycor Systems Div., Digitronics Corp., Albertson, L. I., N. Y.

CIRCLE 320 ON READER-SERVICE CARD

SHAFT POSITION ENCODERS. 4-page Bulletin 316-A describes operation principles and applications of several geared encoders.—Datex Corp., 1307 South Myrtle Ave., Monrovia, Calif.

CIRCLE 321 ON READER-SERVICE CARD

HI-SPEED PRINTERS. 6-page brochure describes with specs 3 series of heavy duty printers.—Anelex Corp., 150 Causeway St., Boston 14, Mass.

CIRCLE 322 ON READER-SERVICE CARD

HIGH-SPEED SAMPLING RELAYS. 2-page Catalog Insert F-2218 illustrates with technical details line of Micro-Scan relays.—James Electronics, Inc., (formerly James Vibrapowr Co.), 4050 North Rockwell St., Chicago 18, Ill.

CIRCLE 323 ON READER-SERVICE CARD

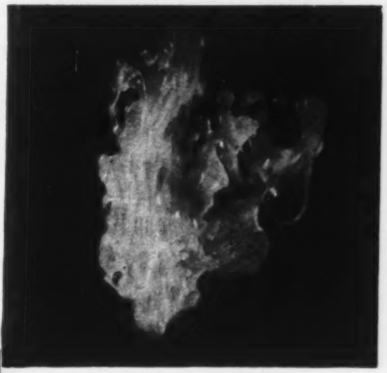
RECORDERS

AUDIO RESPONSE PLOTTER. 2-page bulletin illustrates and describes audio response plotter, Model ARP-2, which provides permanent pen-written frequency response curves of any audio-range equipment.—Southwestern Industrial Electronics Co., a div. of Dresser Industries, Inc., 10201 Westheimer Rd., Houston 27, Tex.

CIRCLE 324 ON READER-SERVICE CARD

CHEM LAB RECORDER. 20-page Bulletin R describes potentiometric recorder for electrical variables in electrolytic systems.—E. H. Sargent & Co., 4647 West Foster Ave., Chicago 30, Ill.

CIRCLE 325 ON READER-SERVICE CARD



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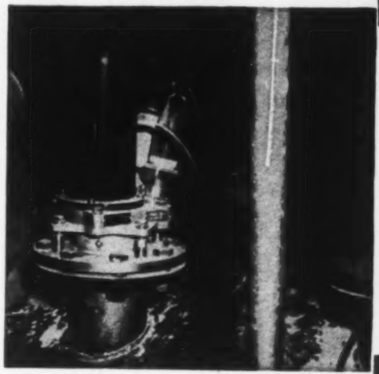

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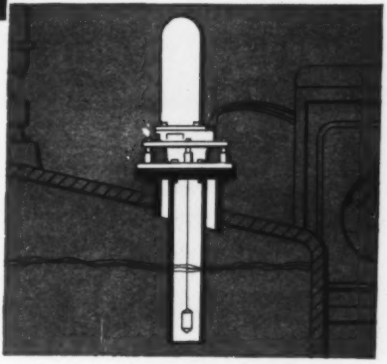

UNDER actual process conditions, the Brookfield Viscometran accurately and continuously measures, records and controls viscosity. Readily mounted and integrated in existing processes, the Viscometran offers significant economic advantages over other methods of indicating degree of reaction, degree of polymerization or determination of process end point.

Viscosity is very likely a variable that is fundamental in your process. For complete information about how the Brookfield Viscometran can provide continuous "in process" measurement of this product dimension for you, write—

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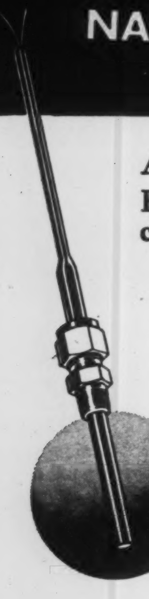
CIRCLE 141 ON READER-SERVICE CARD



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NANMAC "PENCIL PROBE" THERMOCOUPLE

A NEW DESIGN . . .
For the first time - a pencil probe thermocouple with the following features:

- ✓ *Response time - less than 10 microseconds to transient flow.*
- ✓ *A continuous service temperature of over 2000° F.*
- ✓ *A sensing tip with unlimited life.*

Sensing tip constructed with flat ribbon thermocouple wires of .001 inch thickness and mica insulation of .0002 inch thickness. Thermocouple can be used as a surface, in-wall, or immersion thermocouple. Adjustable gland nut assures pressure seal to 3,000 PSI. All stainless steel construction. Available in all standard thermocouple combinations.

For additional details and models write for Technical Bulletin 250

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CIRCLE 142 ON READER-SERVICE CARD

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NEW PYRO MICRO-OPTICAL PYROMETER

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CIRCLE 144 ON READER-SERVICE CARD

NEW LITERATURE

TESTING MACHINE RECORDER. 24-page Bulletin RI-8-57 describes Model RD-5 electronic recorder for maker's testing machines; also accessories.—Riehle Testing Machines, a div. of American Machine and Metals, Inc., East Moline, Ill.

CIRCLE 326 ON READER-SERVICE CARD

AIR, GAS

COMPRESSED AIR PRODUCTS. 24-page Catalog 158 describes and specifies filters, regulators, lubricators, drains and accessories.—Wilkerson Corp., Englewood, Colo.

CIRCLE 327 ON READER-SERVICE CARD

FILTERS. 4-page Bulletin GEO-514 describes and specifies hi-capacity Fulflo filters for liquids and gases.—Commercial Filters Corp., 2 Main St., Melrose 76, Mass.

CIRCLE 328 ON READER-SERVICE CARD

ELECTRICAL, ELECTRONIC INSTRUMENTS

LABORATORY STANDARDS. 24-page brochure "World Standards" includes d-c voltmeters and ammeters; a-c or a-c/and/d-c voltmeters, ammeters, and wattmeters; current transformers; and low-voltage standardizing potential transformers and high voltage-potential transformers.—Weston Instruments Div., Daystrom, Inc., 614 Frelinghuysen Ave., Newark 12, N. J.

CIRCLE 329 ON READER-SERVICE CARD

SUBMINIATURE CARRIER SYSTEMS. 2-page Bulletin 582 R on Models T-582 and T-583 instrument translators contains descriptive material and specs.—Crescent Engineering & Research Co., North Peck Rd., El Monte, Calif.

CIRCLE 330 ON READER-SERVICE CARD

AUTOMATIC CHECKOUT EQUIPMENT 4-page brochure describes an rms-to-dc converter, a voltage-to-digital converter, a timer-counter, and a digital printer.—Epsco, Incorporated, Equipment Div., 275 Massachusetts Ave., Cambridge 39, Mass.

CIRCLE 331 ON READER-SERVICE CARD

D-C POWER SUPPLY. 2-page Bulletin No. 178A covers units with unfiltered outputs ranging from 6 to 230 vdc and 0.6 to 150 amp.—Opad Electric Co., 43 Walker St., New York 13, N. Y.

CIRCLE 332 ON READER-SERVICE CARD

ELECTRICAL, ELECTRONIC COMPONENTS

MYLAR CAPACITORS. Two 4-page catalog sheets cover Mylar paper capacitors and metallized Mylar capacitors.—Plastic Capacitors, Inc., 2620 N. Clybourn, Chicago 14, Ill.

CIRCLE 333 ON READER-SERVICE CARD

WAVEGUIDE DATA CHART. Wall-size Standard Waveguide Data Chart features military as well as EIA designation numbers.—Narda Microwave Corp., 118-160 Herricks Rd., Mineola, N. Y.

CIRCLE 334 ON READER-SERVICE CARD

CAPACITORS. 16-page Catalog MP-59038-E-160 specifies and tabulates 10 types of high-reliability capacitors.—Electron Products Div. of Marshall Industries, 2065 Huntington Dr., San Marino, Calif.

CIRCLE 335 ON READER-SERVICE CARD

PRECISION RESISTOR WIRE. 12-page catalog contains complete and detailed data on low-density/high resistivity Alloy 815-R precision resistor wire.—Hoskins Mfg. Co., 4445 Lawton Ave., Detroit 8, Mich.

CIRCLE 336 ON READER-SERVICE CARD

MISCELLANEOUS

NOISE CONTROL. 12-page Technical Guide "Audio Spectrum Analysis" deals with suitable instrumentation for product evaluation and practical interpretation of typical noise spectrograms.—B & K Instruments, Inc., 3044 West 106th St., Cleveland 11, Ohio.

CIRCLE 337 ON READER-SERVICE CARD

ANALYZERS. 2-page leaflet describes 6 types of analyzers for process streams; also services rendered.—Analytic Systems Co., 980 N. Fair Oaks Ave., Pasadena, Calif.

CIRCLE 338 ON READER-SERVICE CARD

MECHANICAL COMPONENTS. 512-page pocket size Catalog 61 lists 20,000 items including gear heads, speed reducers, differentials, precision gears, couplings, shafting, electronic hardware, etc.—Sterling Precision Corp., 17 Matinecock Ave., Port Washington, L. I., N. Y.

CIRCLE 339 ON READER-SERVICE CARD

ULTRASONIC THICKNESS TESTERS. 8-page Bulletin A-200 details two portable thickness testers, Audigage Model 5 and Model 6.—Branson Instruments, Inc., 40 Brown House Rd., Stamford, Conn.

CIRCLE 340 ON READER-SERVICE CARD

RUPTURE DISCS. 4-page brochure illustrates and describes 4 types of rupture disc assemblies.—Fike Metal Products Corp., Blue Springs, Mo.

CIRCLE 341 ON READER-SERVICE CARD

CRYOGENIC STORAGE SYSTEMS. 8-page brochure illustrates and describes equipment including vaporizers, liquid-oxygen containers, water fuel tanks, and missile propellant containers.—Ryan Industries, Inc., 870 East 70th St., Cleveland 3, Ohio.

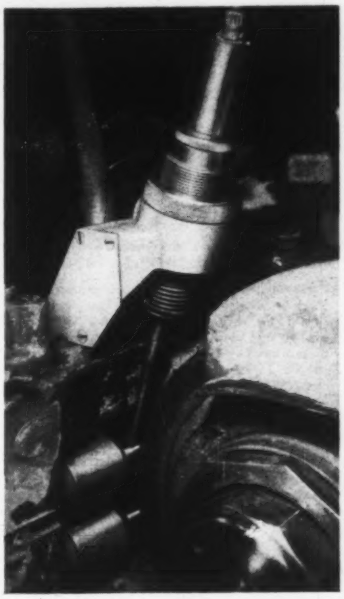
CIRCLE 342 ON READER-SERVICE CARD

TYPE SPECIMENS FOR WAX-LINE ENGRAVINGS. 12-page folder displays 42 type faces.—Royal Electrotype Co., 1309 Noble St., Phila. 23, Pa.

CIRCLE 343 ON READER-SERVICE CARD

SHEET METAL CABINETS. 4-page brochure illustrates cabinets, consoles, and housings for instruments and controls.—Danco Metal Products, Inc., 24000 Detroit Rd., Westlake, Ohio.

CIRCLE 344 ON READER-SERVICE CARD



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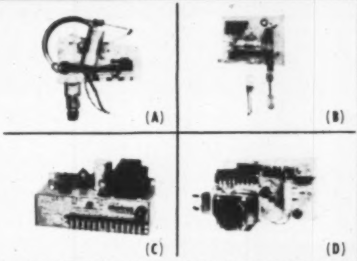

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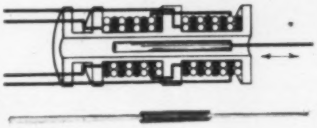

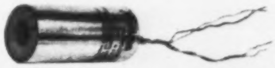

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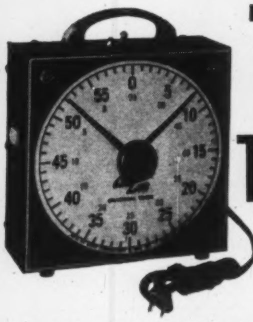

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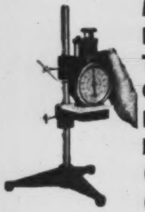

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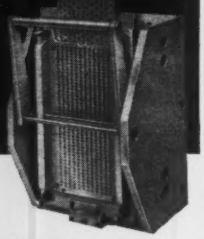

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19	39	59	79	99	119	139	159	179	199	219	239	259	279	299	319	339	
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Valid only: in U.S. and Canada; If filled out completely; Until 6-1-60 **Mar. 60**

Name .... **Title** ....

Company .... **Address** ....

City .... **Zone** .... **State** ....

Principal Product of Your Plant ....

☐ **Check for address change. Show OLD address here:** ....

1	21	41	61	81	101	121	141	161	181	201	221	241	261	281	301	321	341
2	22	42	62	82	102	122	142	162	182	202	222	242	262	282	302	322	342
3	23	43	63	83	103	123	143	163	183	203	223	243	263	283	303	323	343
4	24	44	64	84	104	124	144	164	184	204	224	244	264	284	304	324	344
5	25	45	65	85	105	125	145	165	185	205	225	245	265	285	305	325	345
6	26	46	66	86	106	126	146	166	186	206	226	246	266	286	306	326	
7	27	47	67	87	107	127	147	167	187	207	227	247	267	287	307	327	
8	28	48	68	88	108	128	148	168	188	208	228	248	268	288	308	328	
9	29	49	69	89	109	129	149	169	189	209	229	249	269	289	309	329	
10	30	50	70	90	110	130	150	170	190	210	230	250	270	290	310	330	
11	31	51	71	91	111	131	151	171	191	211	231	251	271	291	311	331	
12	32	52	72	92	112	132	152	172	192	212	232	252	272	292	312	332	
13	33	53	73	93	113	133	153	173	193	213	233	253	273	293	313	333	
14	34	54	74	94	114	134	154	174	194	214	234	254	274	294	314	334	
15	35	55	75	95	115	135	155	175	195	215	235	255	275	295	315	335	
16	36	56	76	96	116	136	156	176	196	216	236	256	276	296	316	336	
17	37	57	77	97	117	137	157	177	197	217	237	257	277	297	317	337	
18	38	58	78	98	118	138	158	178	198	218	238	258	278	298	318	338	
19	39	59	79	99	119	139	159	179	199	219	239	259	279	299	319	339	
20	40	60	80	100	120	140	160	180	200	220	240	260	280	300	320	340	

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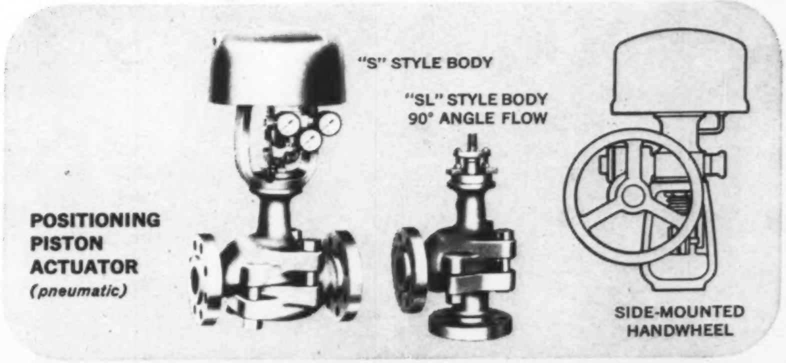
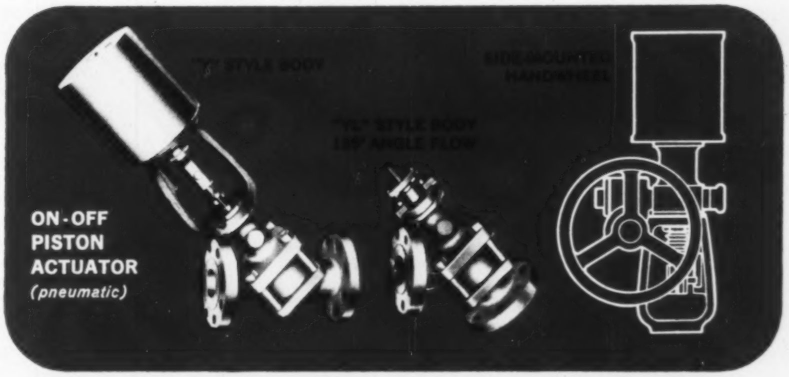
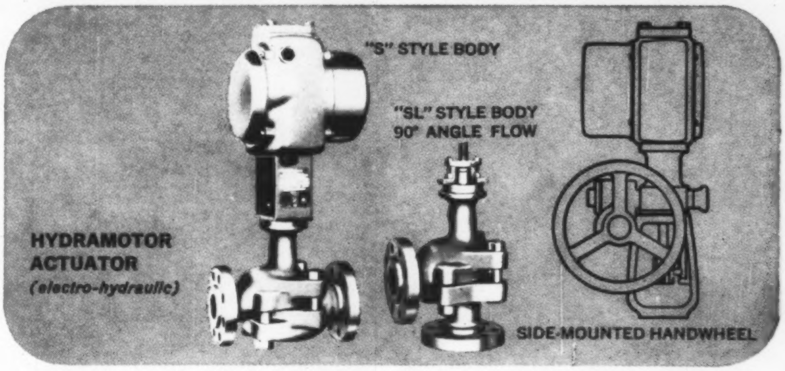

"S" STYLE BODY
"SL" STYLE BODY 90° ANGLE FLOW
POSITIONING PISTON ACTUATOR (pneumatic)
SIDE-MOUNTED HANDWHEEL


"Y" STYLE BODY
SIDE-MOUNTED HANDWHEEL
"YL" STYLE BODY 135° ANGLE FLOW
ON-OFF PISTON ACTUATOR (pneumatic)

DIAPHRAGM ACTUATOR WITH SIDE-MOUNTED HANDWHEEL
"Y" STYLE BODY
"YL" STYLE BODY 135° ANGLE FLOW
MANUAL ACTUATOR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"SL" STYLE BODY 90° ANGLE FLOW
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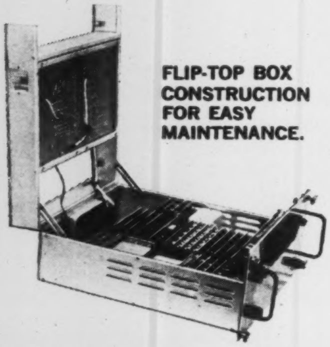

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With Electrical Outputs

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